JARBIDGE RIVER STREAM CHANNEL INTEGRITY INVENTORY

Elko County, Nevada

Prepared for:
Humboldt-Toiyabe National Forest
2035 Last Chance Road
Elko Nevada 89801
(Contract 53-0261-01-08, Task Order SWINAO-4)

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Summary of Scope of Work

The United States Department of Agriculture (U.S.D.A.) Forest Service retained David Evans and Associates (DEA) to conduct an inventory of sediment sources in the Jarbidge River watershed in north–central Nevada. The primary purpose of the inventory was to determine stream channel health by estimating the percent of the stream channel that has been altered by four sources of sedimentation in the watershed. These four sources have been identified as follows:

- Source 1: Areas where the road(s) has(ve) caused stream meanders to initiate bank sloughing and/or hill slope wasting
- Source 2: Areas where channel restriction or channelization has increased channel slope, stream velocities, and shear/stress to lead to channel incision
- Source 3: Areas where bridges constitute channel restriction that has led to increased velocities, scouring, and point bar growth
- Source 4: Areas along the main road where sidecasting of graded material has sloughed into the stream.

DEA and its subcontractor, Portage Environmental, recognize that the information collected in this inventory will help support an environmental analysis on the main road between Pine Creek Campground and the Snowslide Gulch Trailhead. To complete the inventory, deliverables (U.S. Forest Service 2001a) in order of scheduled completion are as follows:

1. Field work plan for the inventory
2. Draft estimate of sources (listed above) introduced into the stream, and estimated amount of material (above background) introduced into the stream on an annual basis
3. Draft inventory report with completed field forms and maps
4. Final inventory report incorporating Forest Service comments on the draft report.

This report is the final deliverable (No. 4, above).

Project Area

The portion of the Jarbidge River watershed for this inventory is located in extreme northeastern Nevada, immediately south of the Idaho border. The region is described as high desert/Great Basin and is characterized by numerous isolated mountain ranges and highly dissected landscapes (in the Snake River Plain area). Elevations range from approximately 6,000 ft (2,000 m) along the Idaho border to just under 11,000 ft (3,400 m) along the headwater divide(s) of the watershed in the Jarbidge Mountains and Humboldt-Toiyabe National Forest. Both the East Fork Jarbidge River and the Jarbidge River mainstem were assessed for this inventory; however, the vast majority of data collection activities were concentrated in the mainstem watershed.

Generally, the lower elevations of the watershed contain bunch grasses and juniper, with cottonwood and willows found in riparian areas. Subalpine fir (*Abies lasiocarpa*), Douglas-fir (*Pseudotsuga menziesii*), and Engelmann spruce (*Picea Engelmanni*) are common in middle and higher elevations. A concise and descriptive overview of the watershed's land uses and vegetation types within the watershed can be found in the *Jarbidge River Watershed Analysis* (McNeill et al. 1997).

Review of INFISH Guidelines

A significant factor affecting the inventory is the existence of the threatened native bull trout (*Salvelinus confluentus*) in the Jarbidge River watershed (64 *Federal Register* 210, 1999). This population of bull trout is disjunct from all other populations of the species, with the next nearest being located in the Boise River watershed, over 150 mi (240 km) to the northwest. *Inland Native Fish Strategy, Decision Notice/Finding of No Significant Impact, Environmental Assessment, Inland Native Fish Strategy, Interim Strategies for Managing Fish-Producing Watershed in Eastern Oregon and Washington, Idaho, Western Montana, and Portions of Nevada* (INFISH) (U.S. Forest Service 1995) is a guiding document that federal land management agencies must follow to ensure compliance with the federal Endangered Species Act (ESA) and to assure protection measures for streams with resident (nonanadromous) native fish.

This inventory describes existing conditions in the Jarbidge watershed, which has undergone channel changes from a flood event in 1995. Several controversial actions were undertaken by various interest groups following the flood, and the U.S. Fish and Wildlife Service issued an emergency protection order for the bull trout under the ESA. Under this order, the standards and guidelines specified under INFISH, as listed below, must be followed to ensure the protection of the bull trout:

- Establish riparian goals and objectives to maintain and restore fish habitat
- Delineate riparian habitat conservation areas (RHCAs)
- Establish standards and guidelines for the management of RHCAs
- Establish criteria and process to designate key watersheds
- Establish criteria and process to guide watershed analysis
- Emphasize the need for watershed restoration actions
- Establish requirements for effectiveness and implementation monitoring.

By providing baseline information and recommendations for monitoring of watershed conditions, this inventory report will assist the Forest Service in adhering to the INFISH standards and guidelines. The understanding and documentation of sediment inputs into the Jarbidge River mainstem will allow the Forest Service to make informed, scientifically based management decisions.

Information and Data Resources

Watershed-scale and site-specific data and information that are relevant to the *Jarbidge River Stream Channel Integrity Inventory* are limited. The U.S. Forest Service and U.S. Geological Survey maintain the primary information resources related to the project scope of work. Climatological data collection platforms, maintained by the National Weather Service and Natural Resources Conservation Service, are also located in the vicinity of the project area.

U.S. Forest Service Resources

U.S. Forest Service personnel provided the following information related to the *Jarbidge River Stream Channel Integrity Inventory.*

- A 1979 data summary titled *West Fork Jarbidge River Channelization Evaluation* (Coffin 1979). The author/researcher evaluated the impacts to fisheries habitat resultant to channelization of 3,104 ft (946 m) of the mainstem Jarbidge River between the Pine Creek Campground and Mahoney Guard Station. The location for the largest channelization segment (1,621 ft [494 m]) was not identified in the report.
- A watershed analysis titled *Jarbidge River Watershed Analysis V 2.3* (McNeill et al. 1997). The report provides a comprehensive overview of the east and west forks of the Jarbidge River, with background to provide a cumulative effects perspective for the drainage.
- A hydrology report titled *Proposal to Reconstruct the Jarbidge Canyon Road From Pine Creek Campground to Snowslide Trailhead*, Elko County, Nevada (Butler 1997). This report provided an estimate for the magnitude of the 1995 peak flow and a geomorphic perspective for the West Fork Jarbidge River.
- August 2001, 1:3000 aerial photography for the entire project area (U.S. Forest Service 2001b).
- September 1993, 1:12,000 aerial photography for the entire project area (U.S. Forest Service 1993).

Each set of aerial photography has sufficient overlap to develop stereo pairs, and most air photo interpretation was completed using a mirror stereoscope.

U.S. Geological Survey Water Resources Data

The U.S. Geological Survey National Water Information System (NWIS) database was queried for streamflow and sediment discharge data for the Jarbidge River and nearby drainage basins (U.S. Geological Survey 2002). Table 1 summarizes data types from the U.S. Geological Survey surface water measurement stations that were reviewed for the inventory. Figure 1 is a streamflow hydrograph for the Jarbidge River for the period April 1998 through July 2001.

Table 1. USGS Surface Water Measurement Stations Reviewed for the Jarbidge River Stream Channel Integrity Inventory.

USGS Station Number	*USGS Station Name*	*Drainage Area* (mi^2)	*Summary of Period of Record for Data Collection*
13162225	Jarbidge River below Jarbidge, NV	30.6	1964-1978 peak flow 1998-present streamflow 1998-1999 sediment
13162500	East Fork Jarbidge River near Three Creeks, ID	84.6	1928-1971 with breaks in streamflow, additional data types available
13174500	Owyhee River below Gold Creek, NV	209	1916-2000, with breaks in record streamflow
13168500	Bruneau River near Hot Springs, ID	2,630	1910-present streamflow
10315500	Marys River above Hot Springs Creek near Deeth, NV	415	1943-2000 streamflow

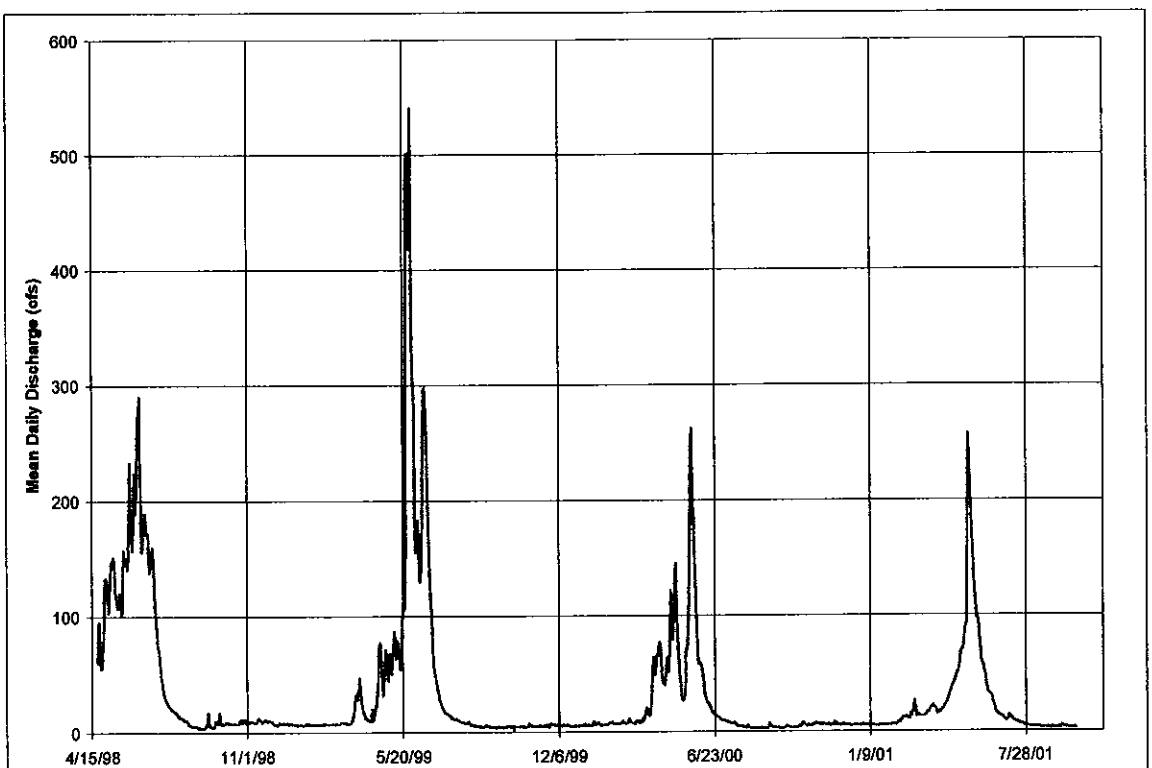


Figure 1. Streamflow Hydrograph: Jarbidge River Below Jarbidge, NV.

Climatology Information

The National Weather Service maintains a cooperative weather station in Jarbidge (Jarbidge 4N, Station 264038). The overall period of record for this station appears to be 1948 through 1995 with significant breaks in record. A summary plot based on a monthly distribution of precipitation data is provided as Figure 2.

The Natural Resources Conservation Service maintains a Snotel data collection platform in Bear Creek and in Seventy-Six Creek, both near the project area. The Bear Creek Snotel station record has been continuously extended back to 1955 based on the Bear Creek snowcourse, which began operation in 1932. Both climatological stations' data were evaluated to develop the moisture conditions antecedent to the reported 1995 flood event in the west fork of the Jarbidge. Figure 3 provides a graphical representation of the monthly snow water equivalent for 1995 and monthly averages for 1995 through 1999.

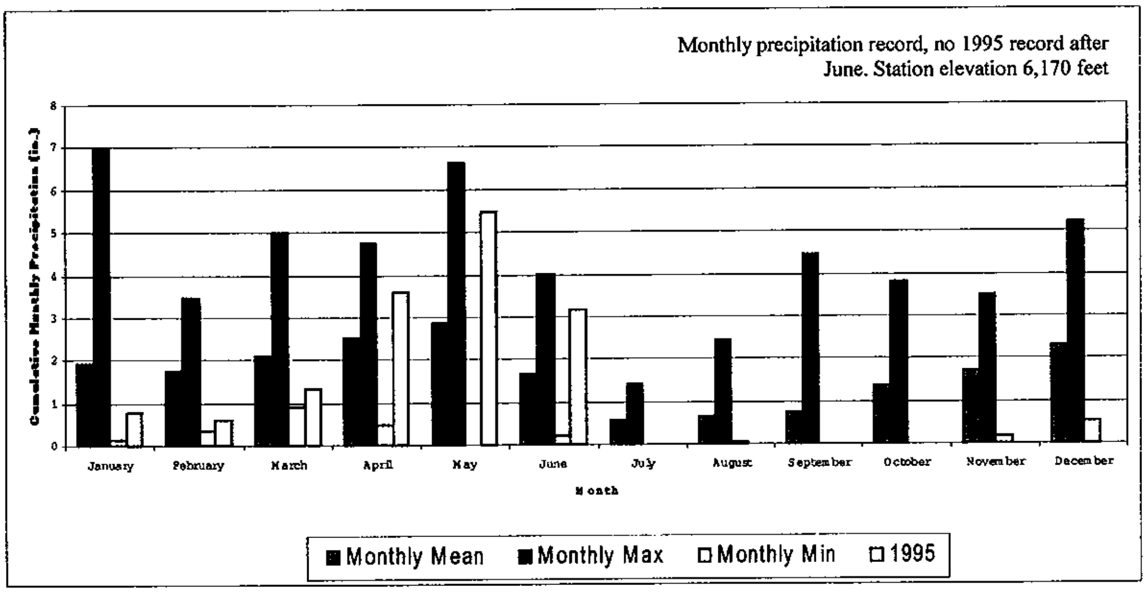


Figure 2. Monthly Distribution of Precipitation: Jarbidge 4N Coop Weather Station.

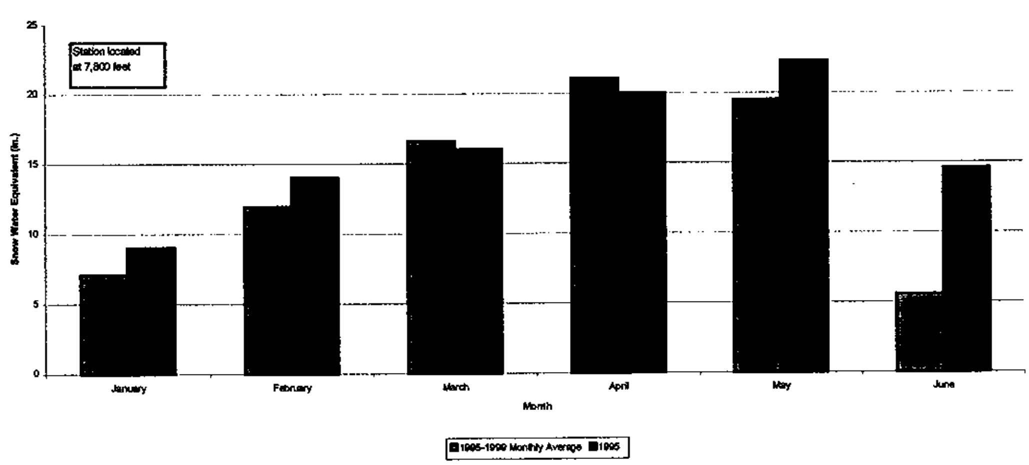


Figure 3. Monthly Snow Water Equivalent Data: Bear Creek Snotel Station.

Additional data and information, which are understood to exist, but were not incorporated into the current inventory include the following:

- Aerial photo flights for additional time periods
- Nevada Department of Environmental Quality water quality sampling results for both the east and west forks of the Jarbidge River
- Fisheries and aquatic resources information collected by the U.S. Forest Service and Nevada State Fish and Wildlife staff
- Geological reports, such as masters theses and geologic maps, which are identified, on the Nevada Bureau of Mines and Geology website (Davis et al. 1998)
- Archival and historical information including historical photography and settlement history.

Additional information and data resources, not identified above, may also exist.

Methods for Field Data Collection and Air Photo-Based Mapping

The Jarbidge sediment source survey and stream channel integrity inventory was completed using a combination of field-based data collection and aerial photo-based mapping and channel measurement. Fieldwork was completed over the period November 1, 2001, through November 7, 2001. The West Fork Jarbidge River was continuously walked from upstream of the confluence with Sawmill Gulch to downstream of the confluence with Jack Creek. The East Fork Jarbidge River was observed upstream of the confluence with Robinson Creek for approximately 2 mi (3 km). During fieldwork, streamflow in the west fork was estimated to range between 4 ft^3 per second (cfs) and 10 cfs, depending on location in the watershed.

Photo Points

Photo points were collected throughout the project area.[a] Photos for the first, second, and third days are located in Appendix A, as are photos for bridge and crossing structures, road-channel interactions, survey reach locations, mine waste rock and tailings locations, and important views of the East Fork Jarbidge River. In the Appendix A photo captions, the photo locations are referenced to one of Map Plates 1 through 6.

SEDIMENT SOURCES TO THE WEST FORK JARBIDGE RIVER

Road Maintenance Sediment Sources

Along several channel reaches, the main valley road is located either adjacent to the active river channel or adjacent to the floodplain of the active river channel. During

[a] This task is identified in the project scope of work (U.S. Forest Service 2001a).

routine road grading and maintenance activities where the road is in the vicinity of the channel, sediment from the road prism can either be sidecast directly into the channel and floodplain environment or windrowed into a berm between the road prism and the channel and floodplain environment. Road maintenance sediment berms are generally unstable and unvegetated and may act as an ongoing source of sediment to the channel and floodplain environment after maintenance is completed. Road maintenance-related sediment sources are identified as Source 4 in the *Jarbidge River Stream Channel Integrity Inventory* scope of work (U.S. Forest Service 2001a).

The length of roadside berm was field measured from the road at the Pine Creek Campground downstream to the Forest Service boundary near the confluence with Jack Creek. This length corresponds to the currently maintained valley floor road system in the project area. The active channel length along this segment is 29,750 ft (9,070 m).

Other roadside berms were measured with a two-person crew using an Advantage Laser Rangefinder (Laser Atlanta Optics 1998) and a signal target. For longer road segments, and road segments that have curvature, shorter road segments were measured and aggregated to increase the accuracy of the overall length measurement.

Results from the roadside maintenance inventory are contained as Appendix B and specific berm locations are reported in Map Plates 3a and 3b. Four data parameters are reported for each measured roadside berm (Appendix B).

1. Berm type—roadside berms (RB) that are located directly adjacent to the active channel or floodplain environment and roadside berms (RB 25) that are within 25 ft (7.6 m) of the active channel or floodplain environment. Areas where the active channel is bordered by recently deposited gravel are reported as active channel.
2. Berm length (ft)—the length of a roadside berm, or segments of continuous roadside berms.
3. Vegetation—a qualitative rating of the sediment filtration capacity of the vegetation located between a roadside berm and the active channel or active floodplain environment. Understory vegetation, including grasses, forbs, and shrubs form the basis for the vegetative rating. Overstory vegetation is not included in the vegetative rating.
4. Berms active/inactive—active roadside berms are identified as recently disturbed and unvegetated or partially vegetated. Inactive roadside berms are identified as fully vegetated berms.

Areas where the road is adjacent to or within 25 ft (7.6 m) of the river, but where no berm was observed, are reported in Appendix B.[b]

Bridges and Crossing Structures

Eleven bridge or crossing structures were identified on the west fork of the Jarbidge River. Two of the crossing structures are older, abandoned features located upstream of Snowslide Gulch. Nine structures are located downstream of Snowslide Gulch and form

[b] In the notes section in Appendix B, there are several measurements of the cross sectional size of the roadside berms. These are maximum width and height measurements that do not account for the generally rounded profile of the berms.

the basis for the bridge inventory. Appendix C contains the bridge inventory results for these nine structures. Bridge and crossing structure locations are shown in Map Plates 5a and 5b. Bridges are identified as Source 3 (U.S. Forest Service 2001a).

For each bridge in Appendix C, except Br-6658T, two data sheets are included. Bridge Br-6658T is abandoned by the active river channel and profile surveying was not completed. The first of the two data sheets contains a summary of the bridge inventory. Inventory criteria were adapted from the Federal Highway Administration (Richardson and Davis 1995). Inventory criteria included channel and floodplain conditions upstream of the bridge section, conditions at the bridge section, and channel conditions downstream of the bridge section. The second data sheet contains a bed surface profile along the thalweg of the channel through each bridge section. Each bed surface profile is surveyed to a reference mark placed in the abutments so the surveys can be repeated.

Road Encroachment and Road Channel Interactions

The valley floor of the West Fork Jarbidge River is generally less than 250 ft (76 m) wide, and within the valley floor, there is a spatial distribution of geomorphic surfaces that further reduce the valley floor, which is accessible to the river. These surfaces include debris fans, colluvial toe slopes, terrace surfaces, and tributary sediment surfaces. As an overlay to the naturally restricted nature of the west fork, the road prism is intermittently located on the valley floor and either currently restricts, or potentially may restrict, the lateral migration of the West Fork Jarbidge River in specific reaches.

Road encroachment may modify the planform pattern of the West Fork Jarbidge River, forcing the channel against a fluvial surface, hillslope margin, or against the fill slope of the road. This process can lead to elevated near bank shear stresses and elevated hillslope, road fill, or fluvial surface erosion. This potential, road influenced erosion process is identified as Source 1 (U.S. Forest Service 2001a).

Road encroachment or channelization can also reduce planform sinuosity and increase reach-scale slopes. Increases in reach-scale slopes can increase the magnitude of the shear stress distribution through a reach and lead to bed degradation or channel incision. This potential process is identified as Source 2 (U.S. Forest Service 2001a). Data worksheets for road encroachment are included as Appendix D and road encroachment and road–channel interaction reaches are delineated on Map Plates 4a and 4b.

Potential channel reaches where road encroachment creates an elevated sediment source were assessed from immediately upstream of Snowslide Gulch downstream to the Forest Service boundary near the confluence with Jack Creek. This corresponds to 38,830 ft (11,800 m) of active channel. Lengths for potential channel reaches encroached upon by the road were field determined using hip chains to measure reach lengths. Wherever possible, the field observer walked the centerline of the channel, and the length of channel identified in the road–channel interaction reaches should closely approximate the autumn, 2001, active channel length.

There are significant segments of the active channel where townsite development, historic mining activities, and campgrounds have encroached on the active channel. The locations for these influences are noted in Appendix D.

Road encroachment reaches, which increase bank erosion or have the potential to increase bank erosion (Source 1), were defined using a combination of field and air photo-based approaches.

- Field inventory was conducted to identify river segments where the active channel or active floodplain is forced against the road prism or a fluvial or hillslope source or will be forced against the road prism or a fluvial or hillslope source.
- Field inventory and air photo interpretation was conducted to identify river reaches with a planform that is modified by the road prism. Evidence for modified planform includes disrupted or truncated meander bends; meander belt widths lower than the observed accessible valley width, channel width information, and elevated floodplain sediment storage in areas away from source contributors (primarily debris fans).
- Comparative air photo interpretation using the 1993 and 2001 aerial photography (U.S. Forest Service 1993, 2001b) was also used to identify planform changes where the active river is migrating toward the road prism.

Potential road encroachment that leads to bed degradation and channel incision (Source 2) is defined based on field inventory. Air photo interpretation formed a secondary tool to determine incised river reaches. The following field features were evaluated to identify potentially incised reaches:

- Disrupted age classes in riparian vegetation on fluvial surfaces
- Stepped point bars on the inside of meander bends
- Obvious nick points or rapid bed elevation changes
- Chute cutoffs or processes leading to reduction in active channel length in the channel and floodplain environment.

There are numerous segments of the West Fork Jarbidge River from upstream of Sawmill Gulch downstream through Moore Gulch that exhibit high (> 15 ft [4.6 m]), actively eroding banks. These reaches are located where the channel is bounded by debris fans or other hillslope sediment inputs. Although these areas initially appear to be actively incising, the researchers believe that debris fan encroachment and other hillslope sediment inputs that force the active channel to excavate through unconsolidated alluvial material is a natural geomorphic process in the Jarbidge watershed. Consequently most, if not all, actively eroding debris fan and colluvial slope areas overlain by the road prism are not identified as incised areas.

There are two locations where there are sediment sources that are identified as road–channel interactions, but which do not fit under the previous road encroachment categories (Sources 1 and 2). Both of these areas are located downstream of Snowslide Gulch in channel segments that were captured by the road during the 1995 flood. The initial river reach is located immediately downstream of Snowslide Gulch where debris inputs from the gulch led to deposition in the floodplain and migration of the active channel to the former road prism. In this instance, the former road fill and road prism sediments are an elevated source, which is intermixed with debris inputs.

Downstream of Snowslide Gulch and upstream of bridge Br-6658T, the channel migrated to the road prism where a debris blockage initiated a channel avulsion. As with the previous instance, the road fill and road prism sediments are an elevated source, which is intermixed with debris inputs.

Time-Series Evaluation of Channel Change and Bar Surface Growth and Decay

The scope of work for the *Jarbidge River Stream Channel Integrity Inventory* identifies, as a task, assessment of the percent of channel that has been altered enough to cause bar growth or decay and/or channel change (U.S. Forest Service 2001a). This work was completed through comparative aerial photo interpretation using the 1993 and 2001 aerial photography (U.S. Forest Service 1993, 2001b).

Geomorphic Evaluation of the Active Channel Environment

This component of the work plan is developed to address the stream channel integrity inventory elements identified in the scope of work (U.S. Forest Service 2001a).

Channel Width Dataset

Channel width is generally a very sensitive indicator of land-use influences on channel geometry. Channel width is a repeatable measurement and is a valid geomorphic indicator at the scale of analysis identified in the scope of work (U.S. Forest Service 2001a).

Over 85 channel width measurements were completed from upstream of Sawmill Gulch to downstream of Jack Creek. Miscellaneous channel widths are also available for the East Fork Jarbidge River. Channel width measurement results are reported in Appendix E and measurement locations are plotted on Map Plates 1a and 1b. Channel width measurement locations are not benchmarked in the field, but the combination of the photography and map location allow for re-measurement with high location repeatability.

Initially the field protocol was to measure only bankfull channel widths. During the course of fieldwork, several river reaches were identified where the channel appears scoured and the channel width reflects the last channel forming flood event, assumed to be the 1995 flood. Based on this observed field condition, there are two types of channel width data.

- Bankfull channel widths where good bankfull indicators are in evidence. The most reliable bankfull indicators for the project area are floodplain surfaces with well-established vegetation. In some instances, point bar crests are used as bankfull indicators.
- Scoured or active channel widths where the active channel is bounded by elevated bar surfaces, often with a levee geometry in cross section. Scoured or active channel widths are often located downstream of debris dominated tributaries.

Survey Reaches

Five river reaches were surveyed in detail to provide insight into geomorphic condition and to provide comparative information for river segments flowing through different valley types. River reaches were surveyed following protocols defined by Harrelson and others (1995), and river reaches were classified following the protocol defined by Rosgen (1994, 1996). Survey results are contained in Appendix F and include the following:

- A reach summary where data and observations are compiled.
- A cross sectional plot. Stream classification parameters are reported for the cross section location.
- A bed surface profile plot completed along the thalweg of the channel and a profile of the bankfull elevation along the same reach length.
- A cumulative particle-size distribution plot. The particle-size distribution was collected as a Wolman pebble count across the surveyed cross sections.

The survey reaches are identified in Table 2. Survey reaches are located to represent the end member valley types observed during fieldwork.

Table 2. Survey Reaches for the Jarbidge River Stream Channel Integrity Inventory.

Survey Reach	*Valley Type*	*Reach Length*
West Fork Jarbidge River downstream of Pine Creek	Alluvial valley with valley width restricted by tributary sediment inputs	350 ft (107 m)
West Fork Jarbidge River downstream of Bonanza Gulch	Incised valley bounded by debris fan	500 ft (150 m)
West Fork Jarbidge River in vicinity of Mahoney Guard Station	Alluvial basin with unrestricted valley width	600 ft (183 m)
West Fork Jarbidge River upstream of Jack Creek	Incised valley bounded by bedrock	500 ft (150 m)
East Fork Jarbidge River upstream of Robinson Creek	Alluvial valley with multiple terrace surfaces	350 ft (107 m)

Comparative Evaluation between the East and West Forks

The east and west forks of the Jarbidge River exhibit similar characteristics in terms of size, geology, hydrologic processes, and basin morphometry. However, land uses in the two drainages have followed divergent paths. The West Fork Jarbidge River has a significant mining and roading history, which is not found in East Fork Jarbidge River history. Further, the east fork has been designated as a wilderness area since 1964. Based on the similarities between the basins, the East Fork Jarbidge River is a potential reference watershed, which may provide insight into pre-land use disturbance conditions for the west fork. Comparative watershed assessment was not identified in the scope of work for the *Jarbidge River Stream Channel Integrity Inventory* (U.S. Forest Service 2001a). However, the work products developed to provide the comparative evaluation have direct applicability to understanding sediment sources in the west fork.

Valley Floor Geomorphic Mapping

Geomorphic map units are delineated for both the east and west forks of the Jarbidge River from headwater areas downstream to below the Forest Service and wilderness boundaries (Map Plates 2a through 2d). The emphasis for the mapping was to identify valley floor sediment types and the hillslope units directly adjacent to the valley floor (the channel influence area [U.S. Forest Service 2001a]). Where the map units continue upslope out of the channel influence area, an indefinite unit boundary line is identified on the maps.

Mapping is based primarily on air photo interpretation using the 1:3000 scale maps as a base, with limited field verification. The maps should be considered as reconnaissance-level work. Map units are identified based on their potential to generate and transport sediment to the valley floor. The geomorphic map units for the Jarbidge Stream Channel Integrity Inventory are identified in Table 3.

Valley Floor Slope Profile

Valley floor slope profiles were developed for both the east and west forks of the Jarbidge River and are reported in Appendix G. Valley slope information is reported from headwater areas downvalley to below the project area boundaries. Valley slopes are determined from the 7.5-minute quadrangle maps for the area.

Overview of Jarbidge Watershed Bedrock Geologic Materials

The east and west forks of the Jarbidge River are underlain by Tertiary-aged, silica oversaturated extrusive volcanic rocks. Three primary mapping units were identified by McNeill and others (1997). The Jarbidge rhyolite is exposed in over 65 percent of the east and west forks of the Jarbidge River in the project area. Welded tuffs, interbedded with ash and volcaniclastic sediments (ignimbrites), are exposed over less than 10 percent of the project area. Ignimbrite exposures along the main road between Jack Creek and Mahoney Guard Station are light tan, very fine grained, and highly erodible. Dacite flows form steep cliffs west of the townsite of Jarbidge, in the vicinity of Jack Creek, and it appears dacite flows, or a similar cliff-forming unit, are the predominant rock type downstream to the confluence with the East Fork Jarbidge River. Throughout the project area, extrusive volcanics are locally veneered by talus slopes or unconsolidated sediments.

Table 3. Geomorphic Map Units for the Jarbidge River Stream Channel Integrity Inventory.

Unit Code	*Unit Descriptor*	*Comments*
B	Undifferentiated extrusive volcanic bedrock	Dominantly bedrock slopes
B/T	Undifferentiated extrusive volcanic bedrock and talus	Bedrock slopes with talus slopes or talus cones, generally at the toe of bedrock slopes
B/C	Undifferentiated extrusive volcanic bedrock and colluvium	Bedrock slopes with colluvial toe slopes or dry colluvial fans
T	Talus	Includes talus slopes and talus fans
C	Colluvium	Includes colluvial slopes, wedges, and dry colluvial fans
D	Debris fans	Individual and coalescing debris fans. Debris fans defined as tributaries with a source area, incised transport gully or rill, and depositional fan at mouth
F	Fluvial deposits	Includes terrace and floodplain deposits
A	Avalanche scour zones	Scour zones in headwater areas

Extrusive volcanic rocks are well recognized to be very unstable at the earth surface and can undergo very high rates of erosion. Glass shards in rhyolites and welded tuffs devitrify to clays and hydrated minerals, and feldspar minerals in rhyolite undergo consecutive alteration to smectitic (expanding) clays. The instability of the bedrock geologic materials, combined with their exposure at high elevation in a snowpack accumulation area, leads to hillslope instability and elevated background sediment loading reaching to the Jarbidge River floodplain.

Elevated hillslope erosional processes are reflected in the 1993 and 2001 aerial photography, specifically for the West Fork Jarbidge River (U.S. Forest Service 1993, 2001b). Several first-order drainages contain large, active mass wasting surfaces in headwater areas. There are also networks of subparallel rills and gullies on most west-facing hillslopes. Map Plates 2a through 2d demonstrate the frequency of formation of debris fans, which reach to the valley floor. Many of the debris fans appear to be composite features and reflect a long history of sediment accumulation from hillslope sources.[c]

[c] This section's discussion was adapted from McNeill and others (1997).

Jarbidge Watershed Hydrologic Background

Climatological Information

Precipitation data for the Jarbidge 4N weather station are graphically summarized in Figure 2 (Western Regional Climate Center 2000). Elevated precipitation generally occurs in fall and late winter with lows in the summer months. As with higher elevation snowpack, 1995 precipitation was elevated above the long-term mean for May and June of that year.

Runoff patterns in the Jarbidge watershed are dominated by snowmelt processes. Seasonal snowpack accumulation patterns are graphically reported for the Bear Creek Snotel station in Figure 3 (National Water & Climate Center 2002). The graph demonstrates a pattern of snowpack accumulation through May and rapid snowmelt depletion in June. Snowpack conditions were anomalous in 1995. Elevated snow-water content was maintained into June and significantly contributed to the 1995 flood event.

Runoff Characteristics

Data are limited to develop the runoff characteristics for the Jarbidge watershed. Historic streamflow data were collected on the East Fork Jarbidge River. There is a historic peak-flow record for the west fork, and there is a short period of continuous record for the West Fork Jarbidge River downstream of the Jarbidge townsite.

A time-series hydrograph for the west fork is included as Figure 1. The runoff pattern for the short period of record reflects a snowmelt-dominated hydrograph, with a late May and early June peak. There is a high peak-to-base flow ratio, indicating there are limited precipitation sources capable of generating runoff aside from spring snowmelt.

During fieldwork, researchers qualitatively observed variation in streamflow magnitudes in reaches without surface water inputs. Field researchers considered that there is a longitudinal pattern of surface and ground water interactions, which influences reach-scale base flow magnitudes.

Peak-flow data collected by the U.S. Geological Survey data are reported in Table 4 for the West Fork Jarbidge River. Peak-flow data for the Jarbidge River were regressed against the Owyhee River below Gold Creek (USGS station 13174500) and the Mary's River above Hot Springs Creek near Deeth (USGS station 10315500) for the period of overlapping record. A very poor correlation was observed, and thus, these longer-term stations could not be used to either develop a longer flood record or a record of the 1995 flood for the west fork. This result was not anticipated and suggests that localized climatic events influenced the magnitude of peak flows in the Jarbidge watershed.

Butler (1997) estimated the magnitude of the 1995 peak-flow event by back calculating the peak flow from high water marks and cross-section hydraulics. The flood estimate was 1,129 cfs, corresponding to a low recurrence interval flood. Review of snowpack and precipitation data indicate that preservation of an elevated June snowpack, combined with greater than normal rainfall precipitation, initiated this flood event. Elevated snowpack may have also contributed to saturated soil and subsoil profiles and detachment of debris in headwater areas. Antidotal information collected from residents during fieldwork

Table 4. Reported Peak-Flow Data for USGS Stations 13162200 (1964-1978) and 13162225 (1998-2001).

Date	*Flow (cfs)*	*Date*	*Flow (cfs)*	*Date*	*Flow (cfs)*
5/27/64	272	6/70	700	5/76	320
6/11/65	267	5/71	400	6/10/77	600
5/10/66	130	1/18/72	210	6/78	125
6/20/67	340	6/27/73	315	6/15/98	290
6/13/68	140	7/10/74	305	5/30/99	541
5/69	470	6/75	549	5/24/00	262
				5/15/01	272

1964 through 1978 are instantaneous peaks (crest stage readings),
1998 through 2001 are mean daily peaks

indicates that high intensity rains were localized and focused in individual tributaries to the west fork.

Bankfull discharge at the U.S. Geological Survey gage was estimated by surveying bankfull indicators and the elevation of the outside staff gage at the elevation of the bankfull indicators. The outside gage reading was 4.80, which equates to a discharge equal to 266 cfs using rating 0002, provided by the Elko, U.S. Geological Survey office.

The bankfull discharge estimate is evaluated using bankfull indicators for the survey reach at Mahoney Guard Station (Appendix F) and the mean velocity for U.S. Geological Survey measurement #42 at the West Fork Jarbidge River measurement site as shown in Equation (1) below.

Continuity Equation ($Q = A \times V$) (1)

$$(31') \text{ bankfull}_{\text{width}} \times (2.1') \text{ mean}_{\text{bankfull depth}} \times (4.43 \text{ fps}) = 288 \text{ cfs.}$$

where:

Q = 229 cfs
Mean velocity = 4.43 fps,
Outside gage = 4.74

This value supports that the previous bankfull discharge estimate (266 cfs) is a good estimate of bankfull discharge near the gaging station.

Comparative Evaluation of the East and West Forks of the Jarbidge River

The east and west forks of the Jarbidge River exhibit similar bedrock geology and basin morphometry. However, the watersheds have had divergent land uses that date back to the development of the Jarbidge mining district, which was focused in the west fork. In 1964, the east fork was designated a wilderness, and low levels of land use commiserate with wilderness status occur in this drainage. Based on physical similarities between the tributaries, and the divergent land uses, the east fork has the potential to serve as a reference watershed to provide insight into pre-land-use disturbance conditions for the west fork.

Hydrologic Comparison

There are eight years of peak-flow overlap (1964-1971) between the east and west forks of the Jarbidge River. This is a very short period of overlap, but a limited regression analysis was completed to discern potential peak-flow similarities between the basins. In the analysis, the East Fork Jarbidge River was used as the independent variable (predictor) and the west fork was used as the dependent variable (Table 5).

The sample set is too limited to draw significant inferences related to hydrologic similarity between the basins, but the following observations were noted:

- Considering the very close proximity of the basins, and the shared headwaters, the correlation for the small sample set is poor.
- The predictor equation overestimated runoff in the west fork for six of the eight flood events. This suggests that the east fork may have higher unit runoff values. This result may be expected based on the greater percentage of headwater area in the east fork.
- The predictor equation underestimated runoff in the west fork for the two largest floods in the small sample set. This suggests that lower recurrence interval floods in the west fork are associated with anomalous climatic events, such as rainfall storms.

Table 5. Peak-Flow Comparisons of East and West Forks of the Jarbidge River.

Year	*West Fork*	*East Fork*	*West Fork predicted from East Fork*	*Residuals*
	Instantaneous peak (cfs)			
1964	272	437	284	-12
1965	267	638	414	-147
1966	130	252	164	-34
1967	340	608	395	-55
1968	140	342	222	-82
1969	470	475	308	162
1970	700	602	391	309
1971	400	798	518	-118

R2 - 0.31, standard error – 155

Geologic and Geomorphic Comparison

Valley Slope

Appendix G contains data worksheets and a plot of valley slope for the east and west forks of the Jarbidge River. Headwater valley slopes are very similar, but starting at an elevation of approximately 7,000 ft (2,000 m), there is a very evident increase in valley slope for the west fork.

Greater valley floor slope for segments of the West Fork Jarbidge River translates into changes in the magnitude of basic geomorphic processes when compared to the east fork.

- For river reaches where there is a difference in valley slope, the west fork maintains a higher river gradient, lower sinuosity, and greater unit stream power values.

- For river reaches where there is a difference in valley slope, hillslope lengths will be greater in the west fork for comparable hillslope areas, and energetic processes leading to downslope detrital movement will be greater in the west fork.

Bedrock Geology

McNeill and others (1997) demonstrated that there is a close correspondence in the occurrence of geologic materials between the east and west forks. The authors reported an increased occurrence of landslide deposits (inferred to be debris fans) in the east fork. One additional notable difference is the presence of a mining district in the west fork, which did not develop in the east fork presumably because economically viable mineralization did not occur in this drainage. Highly mineralized areas, such as the west fork, often exhibit significant structural deformation, such as fracture patterns or faulting and increased mineral alteration to secondary, more unstable mineral assemblages. These same processes may also lead to higher rates of weathering and erosion in the west fork relative to the east fork.

Geomorphic Map Units

Geomorphic mapping (Map plates 2a through 2d) graphically demonstrates the distribution of geomorphic units in each basin. The distribution of geomorphic map units is also reported in tabular format in Table 6.

The length of river channel from headwaters to the 6,000-ft (1,800-m) contour interval is greater for the east fork, in part because of the lower valley slope in the east fork.

Consequently, the percent columns, which identify the percentage distribution of each unit over the reach assessment length, may provide a more direct comparative tool. Overall, there is close similarity between the distribution of map units, but the following points are considered.

- The distribution of bedrock is greater in the East Fork Jarbidge River; in particular, there are two large segments of the upper river, which are mapped as containing a bedrock-bounded channel. Bedrock units are considered the most stable geomorphic materials in the channel influence area.
- The percent occurrence of debris deposits, as well as the magnitude of their occurrence in the channel influence area, is greater for the West Fork Jarbidge River. Considering that the length of river channel in the west fork is lower than the east fork, this result indicates that debris-dominated tributaries form a more significant hillslope and sediment transport process in the west fork when compared to the east fork.

Field observers, as well as McNeill and others (1997), noted that active debris inputs occur in west-facing tributaries to the West Fork Jarbidge River. This is underscored by comparing debris inputs for the 1995 flood from Bonanza or Snowslide Gulch (west facing) and Sawmill Gulch, an east-facing drainage with a large, composite debris fan at the mouth. Each of these tributaries encroaches on the active river, and where the river cuts through debris deposits, there are large actively eroding cut slopes in each debris fan. During the 1995 flood event, both Snowslide and Bonanza Gulch were destabilized, but

Table 6. Comparison Between Distribution of Geomorphic Map Units of the East and West Forks of the Jarbidge River.

	West Fork Jarbidge River		*East Fork Jarbidge River*	
Geomorphic units	*Length of unit adjacent to channel or valley floor margin (ft)*	*Length of unit reported as percent of assessment length*	*Length of unit adjacent to channel or valley floor margin (ft)*	*Length of unit reported as percent of assessment length*
Bedrock	12,060	9	32,100	16
Bedrock/talus and talus	24,980	18	26,935	14
Bedrock/colluvium and colluvium	42,740	32	67,300	33
Debris deposits	21,020	15	18,880	10
Fluvial deposits	33,780	25	48,100	25
Avalanche zones	1,960	1	3,000	2

Notes: (1) Comparison is made from headwater mapping areas on Map Plates 2a through 2d downvalley to the 6,000-foot contour interval. (2) Lengths determined from direct measurement on Map Plates 2a through 2d.

there is no evidence that Sawmill Gulch experienced significant scouring or sediment transporting flows.

Aspect driven processes are generally critical at the watershed-scale, but very difficult to quantify. Table 7 contains a basic comparison of the aspect of debris fans in the east and west forks of the Jarbidge River.

The table demonstrates that there is a greater occurrence of debris-dominated tributaries with a west facing aspect in the west fork of the Jarbidge.

During the aerial photographic interpretation to develop the geomorphic maps, the following differences were observed between the two tributaries to the Jarbidge River:

- An active gully and rill pattern is very evident across large hillslope areas in the West Fork Jarbidge River. This drainage pattern is not as well expressed or as widespread in the East Fork Jarbidge River.
- Recent headwater mass wasting scarps are not observed in the west-facing tributaries to the east fork, but they are observed in several west-facing tributaries to the west fork. In most instances, unstable areas, which are observed in 2001 aerial photography, are also observed in 1993 aerial photography (U.S. Forest Service 1993, 2001b).

Table 7. Comparison Between Debris Fans in the East and West Forks of the Jarbidge River.

West Fork Jarbidge River Aspect		*East Fork Jarbidge River Aspect*	
West	*East*	*West*	*East*
14 debris fans	8 debris fans	11 debris fans	13 debris fans

- Debris fans are located at the mouth of most west-facing tributaries in each drainage. There was no aerial photo-based evidence that debris fans have been scoured by recent flood events in the east fork of the Jarbidge. In contrast, four debris fans were scoured by flood events in the west fork, and significant volumes of debris were transported through two debris fans—Snowslide Gulch and Bonanza Gulch.

Summary of Sediment Sources

The previous collective lines of evidence suggest that basin-scale geomorphic conditions that lead to elevated background levels of erosion and sediment transport are more prevalent in the west fork when compared to the east fork of the Jarbidge River. The presence of debris fans in the east fork does demonstrate that large debris-dominated slope failures do occur in this tributary, but examination of 1993 and 2001 aerial photography suggests that the catalysts that may initiate these events have not occurred in the recent past.

The causal mechanisms, which initiate differences in the degree of magnitude of hillslope instability in each drainage, may be related to basic geologic constraints, such as structural geologic history or the distribution of geologic units and their weathering characteristics. Additionally, fundamental geologic and geomorphic processes may be exaggerated by fire history and divergent land-use patterns in each tributary.

SEDIMENT SOURCES WITHIN THE JARBIDGE WATERSHED

Potential sediment sources to the floodplain of the east and west forks of the Jarbidge River are of two types: natural sediment sources and anthropogenic sediment sources. Natural sources include sediment derived from hillslope areas, tributary sediment inputs, and fluvial sediment sources, including detachment and mobilization of channel bed and bank materials. Anthropogenic sources include a suite of land uses, which generate sediment or influence the magnitude of natural erosional processes. Anthropogenic sources are focused in the west fork because of land-use history and may include the following:

- Channel bank erosion, which results from road encroachment and restriction of planform channel migration—Source 1 (U.S. Forest Service 2001a). Channel banks may be formed in hillslope sediment units, fluvial sediment units, or the road prism itself.
- Channel bed erosion, which results from road encroachment and degradation of the bed elevation (incision)—Source 2 (U.S. Forest Service 2001a).
- Sediment contributions, which are derived at bridge sections—Source 3 (U.S. Forest Service 2001a).
- Sediment derived from road maintenance activities—Source 4 (U.S. Forest Service 2001a).

During the course of fieldwork, the following additional anthropogenic sediment sources were identified in the floodplain environment:

- There are several locations where waste rock or mill tailings are located directly adjacent to the active channel. Mill tailings are very fine grained and are readily erodible.
- Development associated with the townsite of Jarbidge has severely disrupted the floodplain and active channel environment in the townsite vicinity. There appear to be limited current sediment contributions associated with the townsite, but historic sediment inputs may have been large.
- There are historic floodplain disturbances, for example, near the Pavlok Mine and Bonanza Gulch Campground, that appear to be related to mining activity. These historic disturbances encroach on the active channel and may have been significant sediment sources, but do not currently contribute elevated sediment loads.
- The U.S. Forest Service campgrounds and interior campground roads are local sources of sediment to the active channel.

Watershed-scale land-use, or land-management, policies may have a significant influence on hillslope sediment contributions and overall watershed stability. As examples, (1) the grazing history in the east and west forks may continue to influence hillslope sediment production, or (2) fire management policies may influence watershed-scale sediment budgets. These activities, although potentially significant, are outside of the channel influence area identified in the scope of work and are not considered in further detail.

Natural Sediment Sources to the East and West Forks of the Jarbidge River

Natural sediment sources are discriminated into three end-member groups—hillslope sediment sources, tributary sources, and fluvial sources. The distribution of these three potential sources is shown in Map Plates 2a through 2d and in Table 7.

Hillslope Sediment Sources

Hillslope sediment sources are driven by energetic processes, which are external to the immediate fluvial environment of the east and west forks of the Jarbidge River. Hillslope sediment sources are considered as background loading, but the magnitude of this sediment source is very significant in the Jarbidge drainage. Hillslope sediment inputs from Snowslide Gulch and downgradient debris-dominated tributaries led to the road obliteration, which occurred in the 1995 flood event.

Hillslope sources are characterized as chronic and episodic in terms of the timing of their input into the floodplain environment. Episodic sediment inputs occur when debris torrents are activated, colluvial slopes undergo mass wasting, or other low recurrence interval events occur. The repeated occurrence of debris fans on the valley floor of the east and west forks of the Jarbidge River demonstrate the significance of infrequent, large events to form the river environment. Field researchers noted that large sediment inputs from the 1995 flood dominate the channel morphology immediately downstream of their input, but their influence rapidly attenuates in a downstream direction. This occurs because flow magnitudes required to transport coarse hillslope sediment inputs occur infrequently. As an example, debris inputs from the 1995 event, which scoured Snowslide Gulch, were only observed to a distance of 1,310 ft (400 m) downstream of the source area.

Chronic hillslope sediment inputs occur on a frequent basis and may include concentrated flow in debris fans, dry ravel from talus or colluvial slopes, or other gravitational processes.

Avalanche Scour Zones

Avalanche scour zones appear, from air photo interpretation, to generate limited sediment, but they are a major source of wood loading to the active channel. Avalanche zones are limited to high-elevation, headwater areas in the east and west forks of the Jarbidge River. Channel areas influenced by avalanches, although entrenched between canyon walls, appear to have high width-to-depth ratios and are locally braided. Channel areas influenced by avalanches were not field observed, but it appears elimination of bankside and riparian vegetation in avalanche pathways may initiate high width-to-depth ratios. Avalanche scour zones are located adjacent to 1,960 ft (597 m) of the west fork and 3,000 ft (914 m) of the east fork above 6,000 ft (2,000 m).

Bedrock

Several valley margin segments of the east and west forks of the Jarbidge are bounded by bedrock, and there are numerous reaches of the channel that have a bedrock substrate. Bedrock generally has a very high resistance to erosion relative to other slope-forming materials in the Jarbidge watershed. Other than individual boulders or large rock clasts, bedrock sediment sources are not considered a significant hillslope source at the scale of the project objectives. Bedrock is located adjacent to 12,060 ft (3,676 m) of the west fork and 32,100 ft (9m780 m) of the east fork above 6,000 ft (2,000 m).

Talus

Talus slopes and talus cones are distributed throughout the Jarbidge drainage. Talus slopes are generally stable at their angle of repose, but where the active channel undercuts the toe of a talus slope, large angular rock is introduced into the channel environment. There are several short reaches where channel pattern is influenced by talus inputs. Talus and bedrock intermixed with talus are located adjacent to 24,980 ft (7,610 m) of the west fork and 26,935 ft (8,210 m) of the east fork above 6,000 ft (2,000 m).

Colluvium

Colluvium is used in the context of this inventory to describe slope-forming material that, in streamside exposures, contains a bimodal particle-size distribution consisting of large, angular rock fragments and sand and finer size fractions. Colluvial materials, because of the presence of fine-grained matrix material, may become saturated and move downslope at slopes lower than their angle of repose. Where the active channel undercuts the toe of colluvial slopes, slope materials may become unstable and form large, actively eroding banks. This sediment source occurs in short segments throughout the project area. Colluvium and colluvium intermixed with bedrock is located adjacent to 42,740 ft (13,000 m) of the west fork and 67,300 ft (20,500 m) of the east fork above 6,000 ft (2,000 m).

Debris Fans

Debris fans form large sediment wedges that generally force the active channel to the opposite valley margin. The hillslope component of sediment derived from debris fans tends to be very large substrate that is generated during infrequent debris torrents. It appears that more frequent runoff events are incapable of mobilizing most sediment size fractions on debris surfaces. The recurrence interval of large debris torrents in the Jarbidge basin is not known but appears to be low, based on the general stability of most debris surfaces in the east and west forks of the Jarbidge River.

The 1995 flood event obliterated two sections of the main road and introduced large volumes of sediment, which persist in the floodplain environment immediately downstream of each debris material source. Approximately 48,000 ft (14,6000) of the West Fork Jarbidge River were directly observed in the field. Over this length of channel, between 10 and 20 percent of the channel exhibited direct influences from hillslope debris torrents generated during the 1995 flood event. There are 22 identified debris fans in the west fork and 24 identified debris fans in the east fork above 6,000 ft (2,000 m).

Tributary Sediment Sources

There are several large tributaries in the Jarbidge watershed. They are often east-facing drainages, with notable exceptions of Jack Creek in the west fork and Slide and Robinson Creeks in the east fork. No data are available to determine the amount of sediment discharge, which these channels generate during elevated runoff events. At their confluence with the mainstem channels, there are often large sediment wedges, which may continue downstream for several channel widths. These sediment wedges are intermediate in form between terrace surfaces and debris fans. Tributary sediment surfaces may encroach on the active channel width, but they generally do not exhibit active eroding scarps and do not appear to be significant sources of sediment to the mainstem channels.

Overall, the main perennial tributaries do not appear to be large sediment sources. This observation is corroborated by the lack of small deltas or depositional zones at the confluence of tributary channels with the mainstem of the east and west fork channels.

Fluvial Sediment Sources

Fluvial sediment sources occur where the active river channel interacts with the bed and banks of the channel and mobilizes sediment particles. Fluvial processes often interact with hillslope sediment sources, and by undermining toe slope areas may initiate hillslope instability.

Terrace and Floodplain Sources

Terrace and floodplain scarp erosion occurs along the length of the project reach. In general, terrace surfaces bordering the active channel are less than 6 ft (2 m) in height, and this forms a limiting height for erosional surfaces. Anthropogenic terrace and floodplain scarp erosion sources, which are related to road encroachment or bridge sections, are identified in following sections. Combined, fluvial sediments border 33,780 ft (10,300 m) of the west fork and 48,100 ft (14,700 m) in the east fork above 6,000 ft (2,000 m).

Hillslope Sources in the Fluvial Environment

There are repeated reaches of the east and west forks of the Jarbidge where the active channel is bounded by the toe slope area of a hillslope sediment source. In all instances where debris fans encroach on the active channel, large (often > 15 ft [4.6 m]) active slope erosion is occurring. This includes both active and inactive debris fans. It appears that slope erosion in debris fan areas is a natural process and is the most significant natural fluvial sediment source in the Jarbidge inventory area. Where the active channel impinges on other hillslope sediment types, specifically colluvial materials, eroding slopes can also form a significant sediment source.

Summary of Natural Sediment Sources

It is extremely difficult, and a highly intensive data-collection effort, to provide a quantitative estimate of natural sediment loading in the Jarbidge watershed. Sediment sources can be characterized as high-magnitude, low-frequency, or low-recurrence interval events. These sources would include debris torrents, major hillslope failures, or extreme flood events. Alternatively, sediment sources can be characterized as low to intermediate magnitude, higher frequency events and would include annual flooding and bank scour processes and minor hillslope failure.

Geomorphic processes with low to intermediate magnitude and a high frequency of recurrence are generally considered to "do" more geomorphic work, in this case sediment loading, over a longer time span than less recurrent, but higher magnitude events. This premise was reviewed in detail by Leopold and others (1964).

Low-frequency events, such as the 1995 flood event and associated debris torrents, reworked the floodplain environment immediately downstream of their input. However, based on field observation in the west fork and comparative evaluation of the 1993 and 2001 aerial photography, it appears that annual bank scour and other higher frequency erosional processes introduce more sediment into the active channel than infrequent events, when considered over longer time scales.

When viewed qualitatively, the relative contribution of natural sediment sources appears to approximate the following sequence: fluvial sources introduce the greatest amount of sediment into the active channel, followed by hillslope inputs, and finally by tributary inputs.

ANTHROPOGENIC SEDIMENT SOURCES IN THE WEST FORK OF THE JARBIDGE RIVER

Source 1—Reaches where Encroachment Restricted the River Planform Pattern and Initiated Bank and Road Prism Erosion

The magnitude of sediment from Source 1 (U.S. Forest Service 2001a) is summarized in Table 8. Information to develop Table 8 was extracted from information in Appendix D and Map Plates 4a and 4b.

Table 8. Summary of Sediment Sources Related to Bank Erosion: Source 1—Road Encroachment Leading to Bank Erosion.

River length from upstream of Snowslide Gulch to USFS boundary in vicinity of Jack Creek = 38,830 ft—corresponds to river segment with active or recently active road in valley floor		
River segments where road encroachment has initiated bank erosion		
Length of river with active or potentially imminent bank erosion	*Percent of total reach length*	*Reaches used in tabulation (Appendix D)*
4,610 ft	11.9	R3, R5, R14, R20, R22, R24, R28, R30, R31, R33, R34, R35, R37
River segments where roach encroachment significantly restricts accessible valley width, but current or potentially imminent bank erosion is not observed		
Length of river with significant restriction	*Percent of total reach length*	*Reaches used in tabulation (Appendix D)*
2,317 ft	6.0	R7, R23, R30
River segments where road obliteration by debris inputs combined with the former road prism is a sediment source		
Length of obliterated road	*Percent of total reach length*	*Reaches used in tabulation (Appendix D)*
1,622 ft	4.2	R1, R13, R14

Source 2—Reaches where Encroachment Restricted the River Planform Pattern and Initiated Channel Incision

The presence and magnitude of bed degradation and channel incision (Source 2) can be difficult to determine without a time series of geomorphic information, such as cross sections or geomorphic maps. Absent these or other time-series data sources, the observer must evaluate the preserved geomorphic record in the channel and floodplain environment for evidence of incision.

Observational approaches cannot be used to determine reach-scale bed scour that may occur on the rising limb of a flood hydrograph if deposition occurs subsequent to scour, generally on the falling limb of a flood hydrograph. This couplet of mechanisms may not lead to net bed degradation (incision), but may signal disequilibria in a channel.

Geomorphic field indicators, which were evaluated to determine incision, are identified in detail in the Sediment Sources to the West Fork Jarbidge River section and are summarized as follows:

- Disrupted age classes in riparian vegetation on fluvial surfaces—No clear vegetative evidence was observed suggesting net channel incision. There are many reaches with mature vegetation (4 to 8 inches diameter breast high) on low-terrace surfaces (see photos in Appendix A). At these locations, incision does not appear to be an active process.
- Stepped point bars on the inside of meander bends—Stepped point bars may indicate zones of active incision. Scouring or disruption of the profile on point bars was observed, but was generally associated with scouring related to the 1995 flood event.
- Obvious nick points, or rapid bed elevation changes—Rapid changes in bed elevation were often observed, but field researchers did not identify reaches where progressive bed elevation changes were leading to channel incision. This geomorphic indicator also has greater applicability in fine-grained substrates.
- Chute cutoffs or processes leading to reduction in active channel length in the channel and floodplain environment—Often processes of incision can be detected by observing the geomorphic record in the floodplain environment. Chute cutoffs are channel segments where there is potential for the active channel to be abandoned and shortened, which can lead to an increase in slope. One significant chute cutoff was observed and is depicted (photo 2-17) in Appendix A.

No definitive age markers, or other definitive marker beds or anthropogenic materials, were observed in terrace or hillslope scarps. However, immediately downstream of Bourne Gulch and bridge Br-6236T, two stratigraphic units were observed that might provide insight into potential incision processes. The section is described below and shown in Appendix A (photos 3-6 and 3-7).

- Lower unit 6.5 ft (2.0 m) from current bed surface to top of unit—rounded and poorly cemented gravels—inferred to be terrace scarp.
- Burn line and burned timbers and metal—inferred to be 1919 fire marker when townsite of Jarbidge burned.
- Top unit 7.0 ft (2 m) from burn line to current ground surface—bimodally sorted, angular fragments and sand and finer matrix—inferred to be debris sediments from Bourne Gulch.

Further work would be required to age bracket this section, but it may place a limiting maximum value for incision of 6.5 ft (2.0 m) from 1919 to present for that specific river reach.

River reaches where incision processes may be occurring are identified in Table 9 and were developed with information from Appendix D and Map Plates 4a and 4b.

Table 9. Summary of Sediment Sources Related to Channel Incision: Source 2—Road Encroachment Potentially Leading to Channel Incision.

River length from upstream of Snowslide Gulch to USFS boundary in vicinity of Jack Creek = 38,830 ft—corresponds to river segment with active or recently active road in valley floor		
River segments where road encroachment has potentially initiated localized incision		
Length of river with potential localized incision	*Percent of total reach length*	*Reaches used in tabulation (Appendix D)*
3,234 ft	9.6	R27, R28, R30

Summary statements regarding potential channel incision in the West Fork Jarbidge River follow:

1. There are large sections of the west fork where active deposition is occurring and detrital materials are being deposited on floodplain surfaces.
2. There are a number of reaches in the west fork where the channel is bedrock bounded and potential rates of incision are arrested.
3. Large vertical and actively eroding slopes adjacent to debris fans and other hillslopes are generally considered a natural process in the west fork by the field researchers.
4. The west fork has very limited access to its floodplain, often an indicator of incision. This appears to result from
   a. The restricted valley width
   b. The generally high gradient of the river
   c. The distribution of geomorphic surfaces such as debris fans on the valley floor.
5. There is potential that a period of incision occurred during the early development of the west fork and is related to mining, grazing, and roading. These activities began over 80 years ago, and within the current scope of work for the project, their influence cannot be directly evaluated.

Source 3—Bridge Sections where Higher Velocities have lead to Scour and Point Bar Growth

The Source 3 results discussed in the following subsections include information and data from the bridge and crossing structure photos found in Appendix A, the Appendix C data and graphs, and Map Plates 5a and 5b.

Bridge Br-1

Bridge Br-1 (Br-7275T, Map Plate 5a) is located upstream of the traveled road surface, which was accessible up to 1995. Bridge Br-1 is a failed crossing that, based on vegetation in the former channel, appears to have failed over 30 years ago. It appears bridge failure was caused by sediment infilling at the approach to the bridge. At the time of bridge failure, the road was captured and 388 ft (118 m) of channel were abandoned. The channel environment is currently well vegetated and stable and is not identified as an active sediment source. The current channel elevation is at the same elevation at the invert for the crossing, demonstrating that there has been no net incision near the crossing structure over the recent period.

Bridge Br-2

Bridge Br-2 (Map Plate 5a) is located upstream of the traveled road surface, which was accessible up to 1995. The bridge section is located in a confined part of the channel. The bridge failed at some time in the past and is not identified as an active sediment source. The open span of the concrete abutments is 9.9 ft (3.0 m), less than the bankfull widths measured in the bridge vicinity. The former road prism was located immediately adjacent to the channel upstream of the crossing, but sediment related to the former road prism cannot be discriminated from adjacent fluvial sediment sources because of the time lapse since the road was abandoned.

Bridge Br-3

Bridge Br-3 (Br-6709T, Map Plate 5a, and Appendix C) is located in a crossover section between meander bends. The bridge location potentially controls the reach-scale channel alignment, forcing the channel in the approach section to remain adjacent to tributary sediment inputs from Fox Creek. Elevated bar surfaces upstream of the bridge indicate that there is ponding upstream of the bridge during high flows. Reach channel width data demonstrate that the bridge width is less than the up and downstream bankfull width. The bed surface profile is locally oversteepened at the bridge section.

Cut slope erosion in the approach section is partially attributed to bridge placement. Vegetation is maintaining the banks downstream of the bridge, and eroding cut slopes are not observed. Point bar development up and downstream of the bridge is partially attributed to bridge placement and inlet effective open area.

Bridge Br-4

Bridge Br-4 (Br-6658T, Map Plate 5a, and Appendix C) is a failed crossing structure. The structure was overtopped by debris and the primary channel is located on the left margin of the valley. The bridge appears to have failed during the 1995 flood when flood waters and debris backed up behind a log debris jam. The channel was captured by the road and continues to partially flow in the former road prism. Portions of the debris jam upstream of the bridge are still evident. Upstream and downstream bankfull width measurements are greater than the bridge opening. Bridge related erosion is not currently occurring at bridge Br-4.

Bridge Br-5

Bridge Br-5 (Br-6495T, Map Plate 5a, and Appendix C) is part of the currently active road system. The bridge location forces the channel to the left margin of the valley immediately upstream of the crossing. The bridge location, in combination with downstream bridges, controls the channel alignment below Bridge Br-5. Reach channel width data suggest the bridge opening is less than up and downstream bankfull widths. Profile surveying shows that the bed gradient is greater downstream of the bridge section. Field observation also indicates that the reach downstream of the bridge is steeper and appears to have reduced sinuosity, relative to upstream sections of the channel. The left abutment to the bridge has been reveted with gabions and the approach section to the bridge was dredged at some point in the past.

Cut slopes downstream of the bridge occur in a low-terrace surface and are directly attributed to increased stream power downstream of the bridge section.

Bridge Br-6

Bridge Br-6 (Br-6462T, Map Plate 5a, and Appendix C) is part of the currently active road system. The bridge is located immediately upstream of the debris fan derived from Bonanza Gulch. The bridge, in combination with upstream bridge Br-5, is a control on planform geometry through this reach of the west fork. The bridge opening is less than up and downstream bankfull widths. Field observation and profile information indicate that a sediment lobe is located upstream of the bridge and appears to relate to inlet hydraulics at the bridge. The channel was historically dredged downstream of the bridge. The bed slope increases downstream of the bridge, and this may be related to bridge hydraulics and historic dredging.

Limited direct sediment inputs are associated with the bridge. Historic maintenance in the exit section may have functioned as a sediment source. The bridge does influence planform geometry in the reach vicinity.

Bridge Br-7

Bridge Br-7 (Br-6396T, Map Plate 5a, and Appendix C) is part of the currently active road system. Bridge Br-7 is located in a crossover between two well-developed meander bends. The bridge may locally affect planform geometry, but the effect is not pronounced. Channel width data indicate the bridge opening is equivalent to up and downstream width data. The bridge inlet has poor alignment relative to the active channel and there is potential for debris blockage during flood events. The bed elevation is locally increased through the bridge section.

Cut slope erosion or other direct sediments inputs are limited at bridge Br-7.

Bridge Br-8

Bridge Br-8 (Br-6304T, Map Plate 5a, and Appendix C) is part of the currently active road system. Bridge Br-8 is located in the approach to a meander in a reach with restricted access to the floodplain. The bridge has poor inlet alignment and there is a depositional area upstream of the bridge. There is a 220-ft (60-m) cut slope on the left margin of the approach channel, which is attributed to the bridge. There is also a cut slope in terrace deposits downstream of the bridge, which also is attributed to the bridge. Channel width data indicate the bridge width is similar to reach bankfull channel widths. There is some indication that there was historic dredging downstream of the bridge section.

Cut slope erosion up and downstream of the bridge is attributed to bridge location.

Bridge Br-9

Bridge Br-9 (Br-6236T, Map Plate 5a, and Appendix C) is part of the currently active road system. Bridge Br-9 is located in a section of the channel flowing through debris from Bourne Gulch. The bridge is also located immediately upstream of Jarbidge townsite and appears to have a long history of disturbance. The bridge is located on the downstream end of a meander bend, which is migrating to the left margin of the valley. Channel width data indicate the bridge width is similar to up and downstream channel widths. The bridge alignment is poor. Bed profile data indicate there is bed oversteepening upstream of the bridge section.

There is a large cut slope downstream of the bridge. The cut slope is located in terrace and debris fan sediments and is a large sediment source. The cut slope appears to be related to the presence of debris materials, the lack of bankside vegetation, which appears to be related to human disturbances, and the increased stream power downstream of the bridge.

Bridge Br-10

Bridge Br-10 (Br-6162T, Map Plate 5b, and Appendix C) is part of the currently active road system. Bridge Br-10 is located in the downstream portion of the townsite and in an area with extensive disturbance. Upstream of the bridge, there are large stockpiles of waste rock and tailings and the channel has been recently dredged. Downstream of the bridge section, the channel is contained within a gabion wall system and a vertical cut slope. Channel width data indicate that the bridge width is similar to up and downstream widths. Potential sediment production from the bridge section is masked by the significant disturbance footprint in the reach.

Bridge Br-11

Bridge Br-11 (Br-USGS Gage, Map Plate 5b, and Appendix C) is part of the currently active road system. Bridge Br-11 is located in a depositional reach of the west fork of the

Jarbidge. The bridge is located in a straight section of the channel, which is locally braided. Channel width data indicate the bridge width is similar to up and downstream channel widths. The river has been dredged upstream of the bridge. The reach is depositional, and no cut slope erosion or incision is observed in the bridge section.

Summary of Bridge-Related Sediment Sources

Bridge sections appear to locally influence channel hydraulics and sediment generation. In many instances, cut slope scarps cannot be conclusively attributed to bridge influences. The west fork from bridges Br-5 through Br-8 exhibits reach-scale instability that is partially attributed to the influence of the bridges on channel planform. This reach is evaluated in more depth in a later section of the report.

Source 4—River Reaches where Road Maintenance Activities Introduce Sediment into the West Fork

The river reach that is included in the road maintenance assessment spans from upstream of Pine Creek Campground downstream to the Forest Service boundary, in the vicinity of Jack Creek (reach length = 29,750 ft [9,100 m]). This corresponds to the currently maintained road length in the project area.

The magnitude of Source 4 sediment (U.S. Forest Service 2001a) is summarized in Table 10. Information to develop Table 10 was extracted from reach breakouts in Appendix C and Map Plates 3a and 3b.

Table 9 does not include road prism materials, which are directly sidecast into the active channel. There are approximately 9,360 lineal feet (2,850 m) of road, which are adjacent to, or within 25 ft (7.6 m) of the active channel. The road disturbance prism was intermittently measured to be approximately 30 ft (9 m) wide. These two measurements can be combined to provide an estimate that there are 280,800 ft^2 (26,100 m^2) of road adjacent to, or near, the active channel. It is difficult to estimate the amount of road surface that can be removed during road grading. In part, this relates to road condition, moisture levels in the road, and equipment operator procedures. An order of magnitude calculation is shown as Equation (2), below, that assumes that 1.0 in. (2.54 cm) of the road surface is removed during road grading.

$$280{,}800\ \text{ft}^2 \times 0.083\ \text{ft} = 23{,}310\ \text{ft}^3 = 865\ \text{yd}^3 \quad (661\ \text{m}^3) \tag{2}$$

This value, or one which can be refined by understanding specific grading practices, would bound the total volume of sediment generated during road maintenance. This total volume is then distributed between materials that are directly sidecast from the road prism into the active channel or floodplain and materials sidecast into roadside berms (795 yd^3 [608 m^3] in Table 10).

Road maintenance-related sediment sources are fine-grained materials removed from the road running surface. This sediment source can be introduced into the active channel at times other than high runoff events, such as during rain storms or maintenance programs.

Depending on the timing of road maintenance sediment inputs, this source may have elevated significance to aquatic organisms.

Table 10. Summary of Road Maintenance Sediment Sources: Source 4—Sidecasting Sediment Source.

Berms and road maintenance sources adjacent to the active channel		*Berms and road maintenance sources separated from the active channel by up to 25 ft (7.6 m) of riparian vegetation*	
Length	*Percent of total assessment reach*	*Length*	*Percent of total assessment reach*
4,934 ft	17	4,425 ft	15
Total for both categories			
Length	9,359 ft (2,850 m)	Percent of total assessment reach	31
Estimate of volume of sediment in berms adjacent to the active channel		*Estimate of volume of sediment in berms separated from the active channel by up to 25 ft (7.6 m) of riparian vegetation*	
398 yd^3 (304 m^3)		397 yd^3 (304 m^3)	

Estimate based on application of width and height measurements for berms. Where berm measurements were not available, median cross section (2.6 ft^2 [0.24 m^2]) was applied to berm length

Mine Waste Rock and Tailings

Mine waste rock and tailings are located immediately adjacent to the active channel for a length of 900 ft (300 m) of the West Fork Jarbidge River (see Mine Waste Rock and Tailings Locations in Appendix A). There may be a number of other areas where waste rock and tailings have been used to regrade and level surfaces. These areas would include lands underlying the townsite and the area adjacent to Bridge Br-10.

Tailings and waste rock tend to be highly erodible and may act as an ongoing source of metals toxicity in the aquatic environment.

River Reach Directly Influenced by Townsite

This reach is identified as including the river from bridge Br-10 to the Forest Service boundary, downstream of the townsite. This reach is 2,840 ft (866 m) in length. No direct road-channel interactions are observed in this reach. However, the floodplain surface has been completely modified in this reach and the channel has been forced to the right valley margin. This reach of river was walked as part of the field inventory, and the channel is characterized as a continuous, uniform run with numerous locations where the channel banks have been stabilized.

River Reaches Influenced by Campgrounds

Low levels of sediment inputs are attributed to campgrounds adjacent to the west fork of the Jarbidge River. These campgrounds include the Pine Creek Campground, the Bonanza Gulch Campground, and the campground downstream of the townsite. The Pine Creek Campground is the most significant of the three sources. Approximately 515 ft (157 m) of channel adjacent to the campground has some indication that foot traffic reduces riparian forbs and grasses and may marginally increase sediment loading. Approximately 212 ft (64.6 m) of interior campground road directly encroach on the active channel and function as a direct sediment source.

SUMMARY OF SEDIMENT SOURCES WITHIN THE JARBIDGE RIVER PROJECT AREA

Comparison of Sediment Loads from the East and West Forks of the Jarbidge River

Lines of evidence presented previously in the east and west fork comparative evaluation section of this report strongly suggest that the magnitude of hillslope sediment inputs into the floodplain of the West Fork Jarbidge River exceed the magnitude of sediment inputs into the East Fork Jarbidge River. The causal mechanism for this appears more closely aligned with basic differences in geologic controls between the two basins. However, land uses on hillslopes outside of the channel influence area identified in the project scope of work (U.S. Forest Service 2001a) may contribute to accelerate hillslope sediment inputs in the west fork.

Spatial Distribution of Sources 1 through 4

The spatial distribution of river reaches and road segments where Sources 1 through 4 are located is identified in Table 11.

Table 11. Map Location for Sediment Sources 1 through 4.

Source[a]	*Description*	*Map Plates*
Source 1	Road encroachment leading to bank erosion	Maps 4a and 4b
Source 2	Road encroachment leading to channel incision	Maps 4a and 4b
Source 3	Bridge and locations that influence the channel	Maps 5a and 5b
Source 4	Road maintenance activities leading to sediment loading	Maps 3a and 3b

a. U.S. Forest Service 2001a

Source 1—River Reaches where Road Encroachment has Restricted the Planform Pattern of the River and Initiated Bank and Road Prism Erosion

There are 4,610 ft (1,410 m) of river, or 11.9 percent of the applicable river reach (Snowslide Gulch downstream to USFS boundary) that are experiencing, or will potentially experience, bank erosion related to road encroachment. Bank erosion is occurring in road prism materials, hillslope derived materials, and fluvial materials. Each cut slope location maintains different cut slope heights, lengths, and degrees of vegetative support. Each location also maintains different material competence and reach hydraulic conditions and, consequently, rates of slope retreat. With a time series of information at representative cross sections or bank erosion measurement locations, rates of bank retreat and volumes of material generated from individual cut slopes can be estimated. The three components of road encroachment identified in Table 11 follow:

- Road segments directly leading to bank erosion—4,610 ft (1,410 m)
- Road segments restricting the accessible valley width, but not currently or potentially imminent sediment sources—2,317 ft (706 m)
- Road segments obliterated by debris from the 1995 flood—1,622 ft (494 m).

When these values are combined, there are 8,550 ft (2,610 m), or 22 percent of the applicable river reach, that are directly influenced by road encroachment.

Source 2—River Reaches where Road Encroachment has Restricted the Planform Pattern of the River and Initiated Channel Incision

Channel incision is a process of net bed degradation that can lead to isolation of the river from its floodplain, loss of riparian vegetation and overbank and floodplain aquatic habitat, and increased net stream power in the active channel environment. Where channel incision is not occurring at a dramatic scale, it can be a very difficult process to identify without a time series of information. In the West Fork Jarbidge River, approximately 3,234 ft (986 m) of the channel (9.6 percent of the applicable reach) was identified as potentially exhibiting local incision. Within this reach, one major chute cutoff was observed, which if activated will decrease channel length and lead to a reach-scale increase in slope. Within this reach, there are also large depositional sections of the river.

Source 3—Bridge Sections where Higher Velocities have led to Scour and Point Bar Growth

Bridges Br-5 through Br-8, in combination with the road location, influence the planform geometry of the adjacent river reach and contribute to disequilibrium conditions in the reach.

Other bridge-related influences appear to be restricted to the immediate bridge sections, and they are summarized in Table 12.

Table 12. Summary of Bridge-Related Sediment Contributions.

Bridges which contribute to cut slope instability	*Bridges which contribute to point bar growth*
Br-3, Br-5, Br-8, Br-9	Br-3, Br-6, Br-8

Source 4—River Reaches where Road Maintenance Activities Introduce Sediment into the West Fork

There are currently approximately 795 yd^3 (608 m^3) of sediment stored in roadside berms in the West Fork Jarbidge River between the Pine Creek Campground and the Forest Service boundary. Following assumptions previously discussed, approximately 865 yd^3 (661 m^3) of sediment may potentially be generated during a full road maintenance event.

Review of Sediment Load Data

Suspended sediment and bedload discharge data were collected through a portion of the water year 1998 and 1999 runoff hydrograph at the U.S. Geological survey gage. These data are compiled in Appendix H. The period of record for sediment data is very limited, and all compilations in Appendix H, and inferences made in Table 13, should be viewed in light of the limiting nature of the available data.

Suspended sediment is generally transported over a wide range of flows, and the magnitude of the suspended sediment load is often related to supply. Thus, the load estimate reported for the period of discharge record for water year 1998 cannot be used to estimate the annual load.

Bedload transport generally occurs at a flow magnitude that initiates a critical shear stress capable of entraining bed particles. Bedload transport does not generally occur during low-flow periods, and the estimated load for 1998 may approximate the total annual load.

Bedload results appear anomalous when comparing the two years of record; the reported load for 1998 is much larger than for 1999. The two data sets were separated to develop regression equations because there was significant scatter in the relationship when the

Table 13. Summary of U.S. Geological Survey Sediment Discharge Data for Station 13162225.

Year	*Suspended Sediment load 4/22/98 to 9/30/98*	*Bedload 4/22/98 to 9/30/98*	*Mean daily peak flow for period* (cfs)	*Duration of flows over 100 cfs for period* (days)
1998	221 tons/per 162 days	7,030 tons/per 162 days)	290	66
1999	2,190 tons/per year	302 tons/per year	541	36

years were combined (Appendix H). The discrepancy between the data sets may in part be related to the greater duration of high flows in 1998. There may have also been other unaccounted for influences that affected the bedload relationship. During comparative air photo interpretation, it was observed that 600 ft (200 m) of the channel were dredged upstream of the gage between 1993 and 2001. Additional years of record would be required to develop significant bedload and suspended sediment discharge relationships.

Evaluation of Channel Change

The *Jarbidge River Stream Channel Integrity Inventory* required a comparative analysis of channel conditions between the 1993 and 2001 air photos (U.S. Forest Service 2001a). This effort is summarized in Appendix I and Map Plates 6a and 6b. Map plates showing channel change were not developed for the East Fork Jarbidge River. Two geomorphic features were evaluated, both of which are observable in aerial photography: changes in planform pattern in the channel and growth and decay of point bar or other floodplain bar accumulations. An annual flood chronology was not developed for each year between the photo sets, because of the poor correlation with longer-term stations.

The following channel changes were observed in the west fork of the Jarbidge River:

- Two thousand and twenty five (2,025) feet (617 m) of channel were captured by the road prism where large volumes of debris inputs inundated the channel and floodplain environment. In both cases, there was modification of channel planform and deposition of very coarse debris materials. These reaches are identified as channel change segments CC-1 and CC-5.
- Six hundred feet (600 ft [183 m]) of channel was re-aligned upstream of bridge Br-11.
- Approximately 30,000 ft^2 (3,000 m^2) of new bar surface developed.

In summary, there is very limited change in the planform pattern and bar extents between the photo sets in the West Fork Jarbidge River. Floodplain gravel extents are very similar, but there is some revegetation occurring on bar surfaces located in the 1993 photography. The large depositional alluvial basin downstream of the townsite of Jarbidge has very similar gravel extent between the photo sets, with only limited planform change between the comparable gravel extents.

In the East Fork Jarbidge River, there is a very high degree of similarity between the photo sets. Limited planform change or bar growth and decay was observed.

Previous observations conform to the geomorphic record observed during fieldwork. Where debris torrents have entered the active channel, they significantly influence the channel condition, but their influence rapidly attenuates in a downstream direction.

SUMMARY OF THE GEOMORPHIC CONDITION OBSERVED IN THE CHANNEL INFLUENCE AREA OF THE JARBIDGE RIVER

Summary of Reach Surveying Information

Reach surveying data are summarized in Table 14 and supporting information is provided in Appendix F.

Table 14. Summary of Measured Parameters for Reach Surveys.

Reach[a]	*Bankfull width* (ft)	*Width to depth ratio*	*Entrenchment ratio* (ft/ft)	*Bankfull slope*	*Rosgen classification*[b]	*Stream power*[c] (watts/m^2)
West Fork downstream Pine Creek	36	23	1.8	0.022	B4	1623
West Fork at Bonanza Gulch	33.5	22	2.1	0.029	B4	2140
West Fork at Guard Station	31	14.8	7.7	0.019	C4	1549
West Fork upstream Jack Creek	32	21	1.2	0.008	F4	1402
East Fork upstream Robinson Creek	32	18	4.3	0.009	C4	–

a. Information from Appendix F.
b. Rosen 1994, 1996
c. Stream power calculated as: $\omega = \rho gqs$, where ω = stream power per unit length (watts/m^2), ρ = density of water (1,000 kg/m^3), g = gravitational acceleration 9.80 m/s^2, q = bankfull discharge estimate 7.53 m^3/s, s = surveyed bankfull slope m/m

Geomorphic information summarized in Table 14 and Appendix F provide direct measurement data, which can be used to compare reaches. Stream power estimates demonstrate that the greatest erosive power occurs in the Bonanza Gulch fan.

Channel Width Data Set and Geomorphic Relationships Inferred from Width and Reach Surveying Information

Channel width information is reported in Appendix B as a cumulative frequency distribution. The median channel width measurement for the data set equals 24 ft (7.3 m), and the channel width values at one standard deviation about the median equals 18.5 and 37 ft (5.64 m and 11 m). Specific locations are shown on Map Plates 1a and 1b.

Channel width measurements generally increase in a downstream direction as drainage area and contributing flows increase. This relationship can be influenced by variation in channel slope, the competence of channel margin materials, and land-use influences. The pattern of change in channel width in a downstream direction is reported in two graphical formats in Appendix B – as a plot of channel width reported against cumulative distance downstream, and as a plot of the moving average (step 5, below) of channel width reported against cumulative distance downstream. Channel width measurement observations based on cumulative distance plots are reviewed.

1. Channel width generally increases in a uniform pattern to Pine Creek. Channel widths do increase downstream of Snowslide Gulch, in part as a result of the scoured geometry of the active channel.
2. Channel width increases immediately downstream of Pine Creek, presumably because this is a large tributary to the West Fork Jarbidge River.
3. Channel width values continue to increase downstream to the Bonanza Gulch debris fan. Throughout this reach, width values often exceed the W_{84} value of 37 ft (11 m). This reach of channel contains bridges Br-5 and Br-6 and road-channel interaction reaches R-23 through R-27. These reaches are not identified as significant bank sediment contributors, but they are reported to restrict the accessible valley width and influence planform sinuosity in the channel. The chute cutoff, identified as a potential indicator of reach-scale incision is located in R-27. Combined lines of evidence suggest that this reach of the west fork is in disequilibrium conditions. There is no notable change in the valley slope throughout this reach, and disequilibrium conditions are attributed to bridge placement and road location.
4. Channel width generally decreases through Bonanza Gulch and the downstream river segment. This segment of the channel influence area has very restricted valley width, and this potentially leads to decreased channel width values.
5. The increase in channel width, beginning at 29,600 ft (9.020 m) in the moving average plot, corresponds very closely to greater accessible valley width, and an increase in fluvial sediment storage in the floodplain (width W-61).
6. Widths generally decrease through the townsite. Field observation suggests that there has been significant floodplain encroachment throughout this reach, and incremental reduction in active channel widths. This floodplain process decreases in intensity downstream of bridge Br-10 and this is reflected in the width data.
7. There is a significant reach of the river near the Mahoney Guard Station where the accessible valley width increases and there is major inchannel and floodplain

sediment storage. This set of processes led to a general increase in channel width. Additional observations concerning this reach include the following.

- The valley slope appears to increase downstream of Moore Gulch and through portions of this reach. This is counter-intuitive, in light of the depositional nature of this reach, but one of the primary mechanisms for deposition in this reach is the major constriction in valley width downstream of the Jarbidge landfill.
- The increase in valley slope in the Mahoney Guard Station reach is corroborated by the bed slope data, which is greater than slope in the downstream Jack Creek survey reach.
- The greater valley slope and increase in accessible valley width appear to be directly related to a structural geologic process, or the distribution of geologic materials.
- There is no parallel for this depositional reach in the east fork of the Jarbidge River.

8. Channel width decreases near Jack Creek because of the presence of canyon wall margins adjacent to the channel.

Five channel width measurements were completed in the East Fork Jarbidge River. The average of the width measurements equals 36 ft (11 m).

PRELIMINARY RECOMMENDATIONS

Recommendations related to sediment load and transport processes, geomorphic condition in the Jarbidge River project area, and potential aquatic habitat improvement projects were developed and are provided based on a request for recommendations from U.S. Forest Service personnel. Recommendations provided are outside of the specific framework of the inventory's goals and objectives and when provided affected interest input, the recommendations could potentially be refined to include this feedback.

Monitoring Activities

The Jarbidge River watershed is a complex system that has resulted from fundamentally unstable basin geology, infrequent high-magnitude climatic events, and a century-long legacy of land uses. A time-series data collection program designed to capture the interactive relationship between formative streamflow discharge events and hillslope sediment inputs, and the response in the stream channel and floodplain environment, would work to further quantify and refine understanding of these interrelationships. This type of data collection program would potentially include the following tasks:

- Establish and, on a recurrent interval after channel forming events, maintain a set of measurement reaches where channel geometry and substrate pavement and sub-pavement size distributions are measured. Aquatic habitat and riparian vegetative trends should be measured concurrently with geomorphic parameters. This work should be completed in both the east and west forks of the Jarbidge River.

- The West Fork Jarbidge River appears to be in a disequilibrium condition from downstream of Pine Creek to Bourne Gulch. This same observation was reported by McNeill and others (1997). Findings from this inventory study, and from the work of McNeill and others (1997), indicate instability is related to bridge control on channel alignment and road location. Historic mining and channel dredging may have also destabilized the channel in this reach. A measurement program, such as is identified above, should be implemented in this reach to characterize the causal mechanisms leading to reach-scale instability.
- For individual discharge events capable of initiating sediment transport, complete a synoptic sediment discharge sampling program in the West Fork Jarbidge River. Sampling locations should be placed to isolate specific land uses along the channel, so that relative contributions from these specific land uses may be determined.

Support for Aquatic Habitat Restoration Activities

As a precursor to implementation of aquatic restoration activities, development of a conceptual restoration plan should be considered. This plan would include appropriate planform and cross-sectional design criteria for similar river reaches and valley types within the west fork. This plan also would serve as a tool to integrate aquatic ecological considerations with geomorphic variables. A conceptual restoration plan would guide and facilitate reach prioritization and project cost estimates, reach-scale design and construction planning and documentation, and project permitting within a cumulative effects framework. Conceptual restoration planning would include the following activities:

- Develop an environmental history for the basin. This step would include collecting archival photography and photography maintained by the U.S. Geological Survey at their gaging stations. This step also would involve developing channel planform and riparian vegetation condition maps for the full record of aerial photography in the basin.
- Identify reference reaches and measure reference conditions within identified reaches. Reference reaches should be identified for channel hydraulic and geomorphic conditions and reference aquatic habitat and riparian vegetation conditions. Measurement results, along with planform pattern reconstruction, provide a template for ecological and geomorphic channel restoration.
- Develop the basin hydrology and design discharge requirements.
- Complete a prioritization process to identify restoration reaches, which will achieve aquatic ecological, geomorphic, and other priorities that arise.

Conceptual restoration planning and time-series geomorphic monitoring can, and should, be coupled to efficiently achieve watershed-scale objectives and to provide an objective tool to measure project implementation success.

Road and Crossing Structure Upgrades

Maps and appendices included with this report provide tools to prioritize road infrastructure upgrades. There are a number of factors that should be considered related to road infrastructure upgrades. These factors are distinguished into road maintenance and road re-alignment and crossing structure upgrades.

Road Maintenance

Road maintenance leads to recurrent inputs of sediment into the West Fork Jarbidge River. During field review, there was very limited evidence that structural road-related best management practices (BMPs) or maintenance-related BMPs exist on the road network.

- A suite of BMPs that specifically relate to conditions in the Jarbidge watershed could be developed, implemented, and evaluated through a simplified monitoring program. Through adaptive management, BMPs that are shown to work can be maintained, and BMPs that have lower effectiveness can be modified.
- The appropriate suite of BMPs could be developed by respective agencies with responsibility on the road network with operator training and effectiveness monitoring shared between responsible entities.

Road Re-Alignment and Bridge Upgrades

There are several sections of road identified in map plates and appendices to this report that clearly restrict the accessible valley width. Bridge sections, which have poor alignment, are also identified in maps and appendices to this report. Often the approach roads to bridge sections act as floodplain restrictions, and relief culverts or flow passing road sections were not observed. Combined, materials in the current report can provide a prioritization tool for road and bridge re-alignment.

As West Fork Jarbidge River bridges are upgraded, the following factors should be incorporated into the design:

- No observed bridges in the west fork contain tapered or spill through abutments. This type of abutment can increase effective hydraulic capacity for bridge sections.
- Bridge widths are commonly less than bankfull or active channel width and form a restriction at high flows. Bridge widths should be increased to account for channel restriction.
- In some cases, local bridge alignment makes bridges prone to sediment and debris build up in the approach section. This potential bridge failure mechanism should be addressed during the design review process for bridge upgrades.

Mining Legacy

There are a number of areas where tailings are located adjacent to the active channel and in two locations, the Pavlok and Greylock adits, adit water is flowing directly into the channel. Waters from the Greylock adit have a very detectable influence on the substrate condition of the river for several thousand feet downstream of their input. Available information does not address the aquatic toxicological effects of water from the Greylock shaft. However, during fieldwork, observers qualitatively noted suppression of aquatic macroinvertebrate populations downstream of the adit and development of an iron enriched algal slime covering the substrate. The slime acted as a seal over the substrate and appeared to isolate the water column from the substrate interstitial environment.

Tailings from areas adjacent to the channel can be mobilized during high-flow events. Metals, which are bound to sediment in the tailing, may become soluble and bioavailable in the stream environment, if instream geochemical conditions are appropriate.

All mine-related wastes and discharge waters should be isolated from the active channel, as a part of any comprehensive restoration program implemented in the West Fork Jarbidge River.

REFERENCES

Bibliography

Simons, D. B., F. Senturk, 1992, *Sediment Transport Dynamics, Water and Sediment Dynamics,* Water Resources Publications, ISBN: 0918334667, Fort Collins, Co.

State of Nevada Division of Environmental Protection, 2002, *Bureau of Water Quality Home Page*, Division of Environmental Protection, Carson City, NV, Online via: http://ndep.state.nv.us/bwqp/bwqp01.htm, website last updated–02/13.

Literature Cited

64 Federal Register 210, 1999, "Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for Bull Trout in the Coterminous United States; Final Rule;" *Federal Register*, Department of the Interior, Fish and Wildlife Service, Online via GPO Access [wais.access.gpo.gov], pp. 58909-58933, November 1.

Butler, C., 1997, *Proposal to Reconstruct the Jarbidge Canyon Road From Pine Creek Campground to Snowslide Trailhead, Elko County, Nevada,* U.S. Forest Service.

Coffin, P., 1979, *West Fork Jarbidge River Channelization Evaluation,* U.S. Forest Service, Nevada Department of Fish and Game, Elko Nevada.

Davis, David, A., Ronald H. Hess and Richard B. Jones et al., 1998, *NVGEODEX—Nevada Mining Districts File Index*, Nevada Bureau of Mines and Geology, Online via: http://www.nbmg.unr.edu/lists.htm, website last updated–8/23/00.

Harrelson, C. C., C.L. Rawlins and J.P. Potyondy, 1995, *Stream channel reference sites: An illustrated guide to field techniques,* USDA Forest Service Rocky Mountain Forest and Range Experiment Station, GTR RM-245. P. 61.

Laser Atlanta Optics, 1998, *Advantage Users Guide,* Laser Atlanta Optics, Inc., 2827 Peterson Place, Norcross, GA, 30071, Online via: http://www.laseratlanta.com/Advantage.pdf.

Leopold, L.B., M.G. Wolman and J.P. Miller, 1964, *Fluvial Processes in Geomorphology,* unabridged Dover (1995) republication of the edition published by W.H. Freeman & Company, San Francisco, CA, 1964, Dover Publications, Inc., New York, NY.

McNeill, M.E, Frederick, and J., B. Whalen et al., 1997, *Jarbidge River Watershed Analysis V 2.3,* U.S. Forest Service, Jarbidge Ranger District Humbolt-Toiyabe National Forests.

National Water & Climate Center, 2002, *SNOTEL Data Network*, United States Department of Agriculture, Natural Resources Conservation Service, Online via: http://www.wcc.nrcs.usda.gov/snotel/Nevada/nevada.html, Reno, NV, February.

Richardson, E. V. and Davis, S. R, 1995, "Evaluating Scour at Bridges," third edition: U.S. Federal Highway Administration, *Hydraulic Engineering* Circular no. 18, Publication no. FHWA-IP-90-017.

Rosgen, D.L., 1994, "A classification of natural rivers," *Catena*, v. 22, Elsevier Science, Inc., New York, NY, p. 169-199.

Rosgen, D.L. 1996. *Applied River Morphology,* 2nd Edition, Wildland Hydrology, Pagosa Springs, Colorado.

U.S. Forest Service, 1993, "1:12000 Aerial Photos for the Jarbidge River Stream Channel Integrity Inventory," provided by the U.S. Forest Service, Region 4 Intermountain Region, September.

U.S. Forest Service, 1995, *Inland Native Fish Strategy, Decision Notice/Finding of No Significant Impact, Environmental Assessment, Inland Native Fish Strategy, Interim Strategies for Managing Fish-Producing Watershed in Eastern Oregon and Washington, Idaho, Western Montana, and Portions of Nevada,* U.S. Department of Agriculture.

U.S. Forest Service, 2001, "1:3000 Aerial Photos for the Jarbidge River Stream Channel Integrity Inventory," provided by the U.S. Forest Service, Region 4 Intermountain Region, U.S. Department of Agriculture, August.

U.S. Forest Service, 2001, "Jarbidge River Stream Channel Integrity Inventory," SWINAO-To-17-01-11, Amendment No. 1, *Jarbidge River Contract Package for Region 4 IDIQ Team*, Humboldt-Toiyabe National Forest, U.S. Department of Agriculture, August 30.

U.S. Geological Survey, 2002, *National Water Information System (NWISWeb) Data for Nevada*, Department of the Interior, U.S. Geological Survey, USGS Water Resources of Nevada, Online via: http://water.usgs.gov/nv/nwis/nwis.

Western Regional Climate Center, 2000, *JARBRIDGE 4 N, NEVADA (264038) Monthly Climate Summary* (precipitation data), Desert Research Institute, Division of Atmospheric Sciences, University and Community College System of Nevada, Onlina via: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?nvjarb.

APPENDIX A

Photo Log

Key to Appendix A Photos

Photo Number	Map Location	Map Symbol or Location
1-1	Channel width map plate	W-1
1-2	Channel width map plate	W-2
1-3	Channel width map plate	W-2
1-4		Downstream of Snowslide Gulch
1-5	Channel width map plate	W-4
1-6	Channel width map plate	W-5
1-7		Dry Gulch
1-8	Channel width map plate	W-6
1-9	Channel width map plate	W-7
1-10	Channel width map plate	W-8
1-11	Channel width map plate	W-9
1-12	Channel width map plate	W-10
1-13	Channel width map plate	W-11
1-14		Snowslide Gulch
1-15	Channel width map plate	W-12
1-16		Snowslide Gulch
1-17	Channel width map plate	W-13
1-18	Channel width map plate	W-14
1-19	Channel width map plate	W-15
1-20	Channel width map plate	W-18
2-1	Channel width map plate	W-20
2-2	Channel width map plate	W27
2-3	Channel width map plate	W-28
2-4	Channel width map plate	W-29
2-5	Channel width map plate	W-30
2-6	Channel width map plate	W-31
2-7		Pine Creek
2-8	Channel width map plate	W-32
2-9	Channel width map plate	W-33
2-10	Channel width map plate	W-34
2-11	Channel width map plate	W-37
2-12		Mine site
2-13	Channel width map plate	W-39
2-14	Channel width map plate	W-42
2-15	Channel width map plate	W-44
2-16	Channel width map plate	W-45
2-17	Channel width map plate	DS W-46
2-18	Channel width map plate	W-47
2-19	Channel width map plate	W-48
2-20	Channel width map plate	W-48
2-21	Channel width map plate	W-50
2-22	Channel width map plate	W-56
2-23	Channel width map plate	W-58

Photo Number	Map Location	Map Symbol or Location
2-24	Channel width map plate	W-60
2-25	Channel width map plate	W-49
2-26	Channel width map plate	W-49
2-27	Channel width map plate	W-49
3-1	Channel width map plate	W-61
3-2	Channel width map plate	W-61
3-3	Channel width map plate	W-63
3-4	Channel width map plate	W-65
3-5	Channel width map plate	W-66
3-6	Channel width map plate	Br-9
3-7	Channel width map plate	Br-9
3-8	Channel width map plate	W-67
3-9		Bear Creek
3-10	Channel width map plate	W-71
3-11	Channel width map plate	W-72
3-12	Channel width map plate	W-73
3-13	Channel width map plate	W-74
3-14	Channel width map plate	W-75
3-15	Channel width map plate	W-76
3-16	Channel width map plate	W-76
3-17	Channel width map plate	W-77
3-18	Channel width map plate	W-79
3-19	Channel width map plate	W-80
3-20	Channel width map plate	DS W-81
3-21	Channel width map plate	W-83
3-22	Channel width map plate	W-85
3-23	Channel width map plate	W-87
3-24	Channel width map plate	W-87
3-25		Jack Creek
3-26	Channel width map plate	W-89
B-1	Bridge Inventory map plate	Br-1
B-2	Bridge Inventory map plate	Br-2
B-3	Bridge Inventory map plate	Br-2
B-4	Bridge Inventory map plate	Br-3
B-5	Bridge Inventory map plate	Br-3
B-6	Bridge Inventory map plate	Br-3
B-7	Bridge Inventory map plate	Br-3
B-8	Bridge Inventory map plate	Br-3
B-9	Bridge Inventory map plate	Br-4
B-10	Bridge Inventory map plate	Br-4
B-11	Bridge Inventory map plate	Br-5
B-12	Bridge Inventory map plate	Br-5
B-13	Bridge Inventory map plate	Br-5
B-14	Bridge Inventory map plate	Br-5

Photo Number	Map Location	Map Symbol or Location
B-15	Bridge Inventory map plate	Br-6
B-16	Bridge Inventory map plate	Br-6
B-17	Bridge Inventory map plate	Br-6
B-18	Bridge Inventory map plate	Br-6
B-19	Bridge Inventory map plate	Br-7
B-20	Bridge Inventory map plate	Br-7
B-21	Bridge Inventory map plate	Br-7
B-22	Bridge Inventory map plate	Br-7
B-23	Bridge Inventory map plate	Br-7
B-24	Bridge Inventory map plate	Br-8
B-25	Bridge Inventory map plate	Br-8
B-26	Bridge Inventory map plate	Br-8
B-27	Bridge Inventory map plate	Br-8
B-28	Bridge Inventory map plate	Br-8
B-29	Bridge Inventory map plate	Br-9
B-30	Bridge Inventory map plate	Br-9
B-31	Bridge Inventory map plate	Br-9
B-32	Bridge Inventory map plate	Br-9
B-33	Bridge Inventory map plate	Br-9
B-34	Bridge Inventory map plate	Br-10
B-35	Bridge Inventory map plate	Br-10
B-36	Bridge Inventory map plate	Br-10
B-37	Bridge Inventory map plate	Br-10
B-38	Bridge Inventory map plate	Br-11
B-39	Bridge Inventory map plate	Br-11
B-40	Bridge Inventory map plate	Br-11
B-41	Bridge Inventory map plate	Br-11
B-42		Flatbed car bridge, upstream Jarbidge
B-43		Jack Creek
R-1	Channel width map plate	US W-17
R-2		DS Pine Creek campground
R-3	Channel width map plate	US W-35
R-4	Channel width map plate	W-35
R-5	Channel width map plate	W-36
R-6	Channel width map plate	W-52
R-7	Channel width map plate	W-57
R-8	Channel width map plate	W-57
R-9	Channel width map plate	DS W-83
R-10	Channel width map plate	W-86
R-11	Channel width map plate	W-86
R-12	Channel width map plate	DS W-86
S-1	USGS gage	

Photo Number	Map Location	Map Symbol or Location
S-2	USGS gage	
S-3	Pine Creek survey reach	
S-4	Pine Creek survey reach	
S-5	Pine Creek survey reach	
S-6	Bonanza Gulch survey reach	
S-7	Bonanza Gulch survey reach	
S-8	Bonanza Gulch survey reach	
S-9	Bonanza Gulch survey reach	
S-10	Bonanza Gulch survey reach	
S-11	Mahoney Guard Station survey reach	
S-12	Mahoney Guard Station survey reach	
S-13	Jack Creek survey reach	
S-14	Jack Creek survey reach	
T-1	Channel width map plate	DS W-60
T-2	Channel width map plate	W-68
T-3	Channel width map plate	DS W-68
T-4	Channel width map plate	DS W-68
T-5	Channel width map plate	DS Bear Creek
T-6	Channel width map plate	DS W-69
EF-1		
EF-2	Robinson Hole survey reach	
EF-3	Robinson Hole survey reach	
EF-4	Miscellaneous widths	
EF-5	Miscellaneous widths	
EF-6	Miscellaneous widths	
EF-7	Miscellaneous widths	

Channel Width Measurement Locations and Miscellaneous Photo Points—Day 1, November 02, 2001

Photo 1-1, looking upstream. Map Plate 1a Location: W-1

Photo 1-2, looking downstream. Channel incised in toe of Sawmill Gulch debris fan. Map Plate 1a Location: W-2

Photo 1-3, looking upstream, Channel incised in toe of Sawmill Gulch debris fan. Map Plate 1a Location: W-2

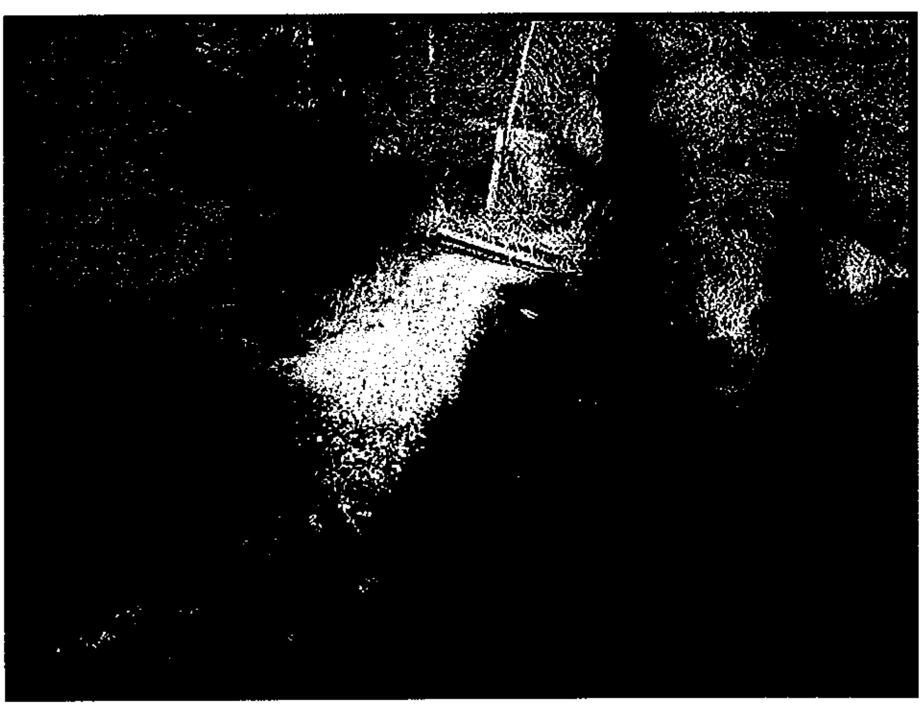


Photo 1-4, looking downstream. Note deposition of spawning size gravel substrate behind large woody debris. Map Plate 1a Location: W-3

Photo 1-5, looking upstream. Map Plate 1a Location: W-5

Photo 1-6, looking upstream. Map Plate 1a Location: W-5

Photo 1-7, looking up Dry Gorge channel. Location at confluence of West Fork and Dry Gorge. Dry Gorge flow estimated ~ 0.8 cfs. Map Plate 1a Location: Dry Gulch, between W-5 and W-6

Photo 1-8, looking upstream. Channel confined within debris from Dry Gorge. Map Plate 1a Location: W-6

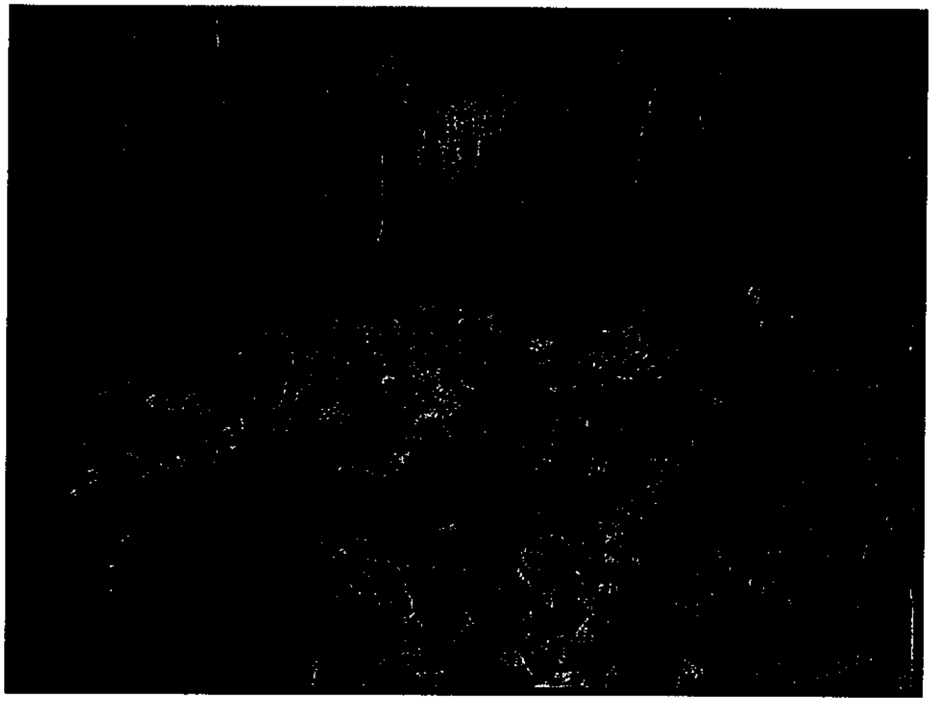


Photo 1-9, looking downstream. Short self-adjusted reach, note floodplain construction on channel margins. Map Plate 1a Location: W-7

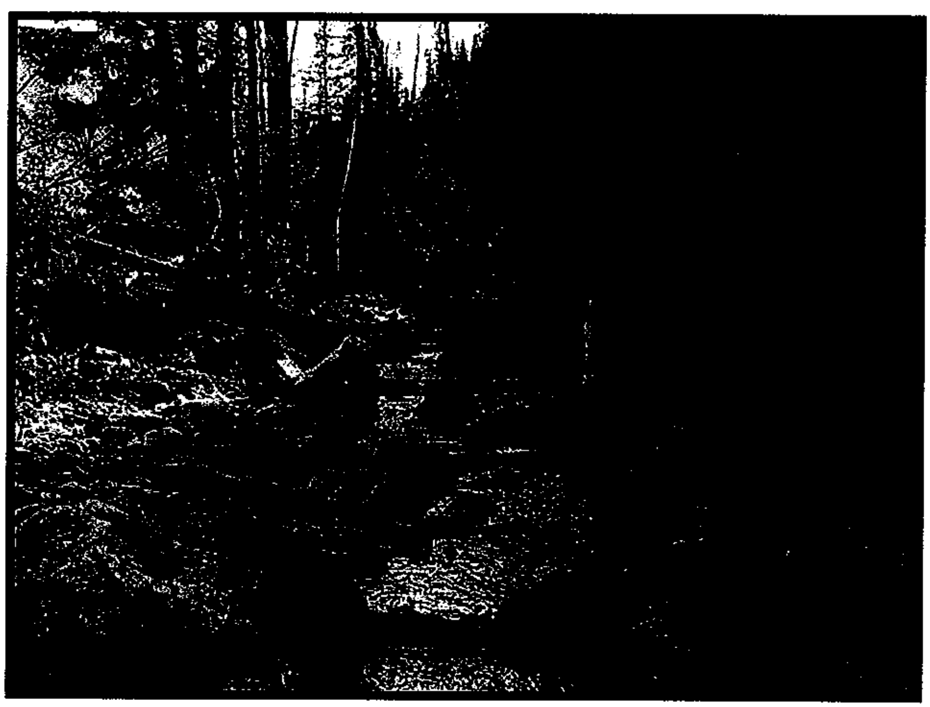


Photo 1-10, looking downstream. Map Plate 1a Location: W-8

Photo 1-11, looking downstream. Failed culvert, inside diameter ~ 56 inches. Note current channel bed at same elevation as culvert invert. Map Plate 1a Location: W-9

Photo 1-12, looking downstream. Map Plate 1a Location: W-10

Photo 1-13, looking downstream. Site immediately upstream of confluence with Snowslide Gulch. Note recent deposition on terrace surfaces. Map Plate 1a Location: W-11

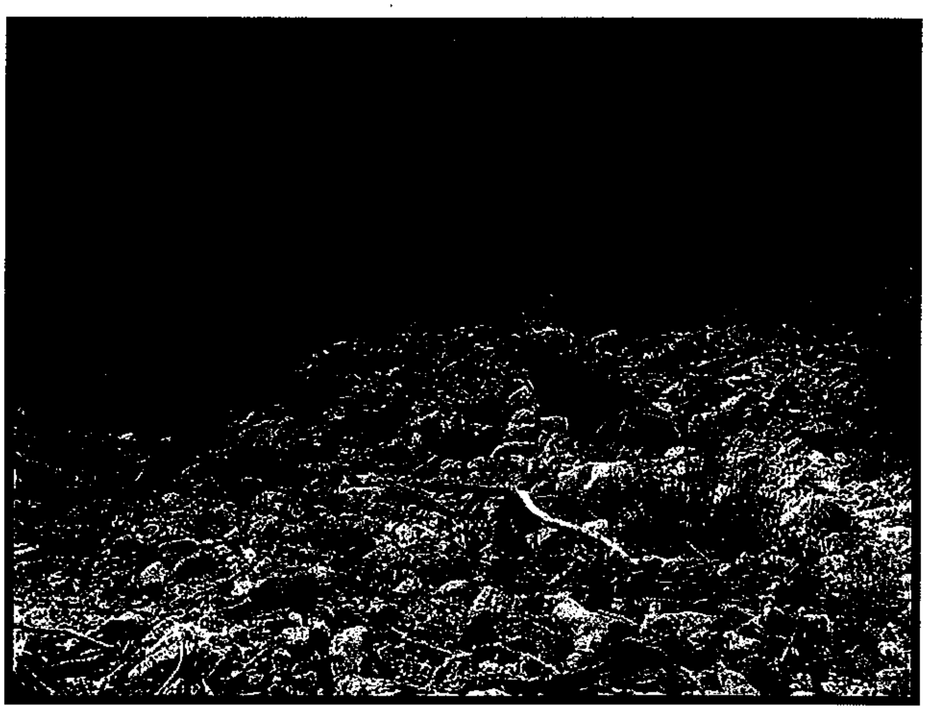


Photo 1-14, looking downstream to West Fork Jarbidge. Photo shows south distributary channel – Snowslide Gulch. Map Plate 1a Location: Snowslide Gulch, near W-12

Photo 1-15, looking downstream. Location in Snowslide Gulch where flow confined to single channel. Map Plate 1a Location: W-12

Photo 1-16, looking upstream into Snowslide Gulch. North distributary channel of SnowslideGulch. Lichen covered and stained rocks in substrate in lower center of photo suggest pre-1995 bed-elevation. Map Plate 1a Location: Snowslide Gulch, near W-12

Photo 1-17, looking downstream. Location immediately downstream of Snowslide Gulch. Note levee construction on left edge of water. Map Plate 1a Location: W-13

Photo 1-18, looking downstream. Road captured by active channel downstream through extent of photo. Map Plate 1a Location: W-14

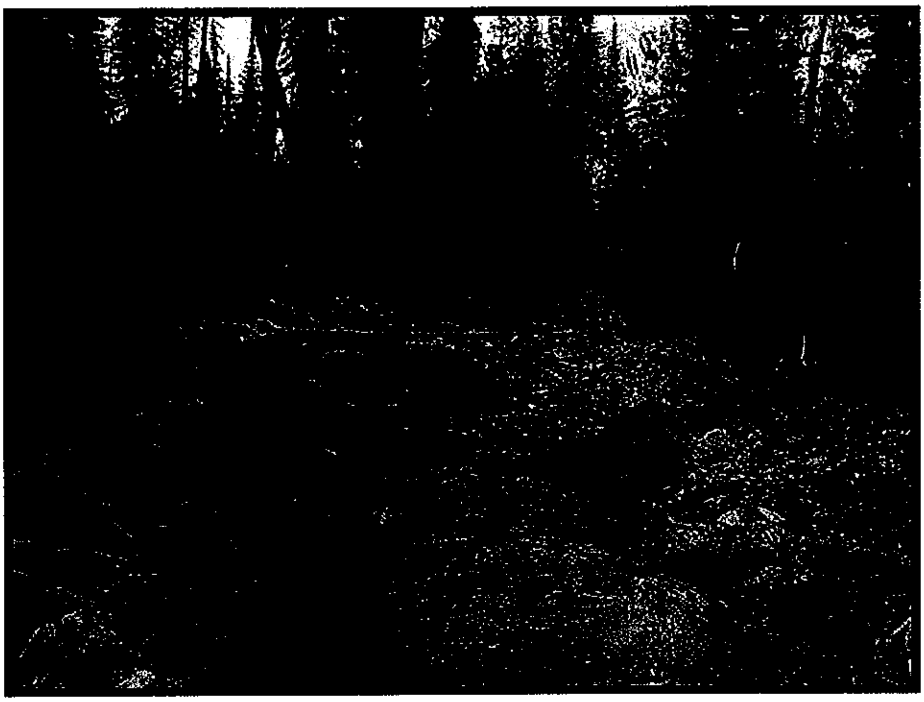


Photo 1-19, looking upstream. Section located in downstream part of Photo 1-18. Channel captured by road in Photo 1-19. Map Plate 1a Location: W-15

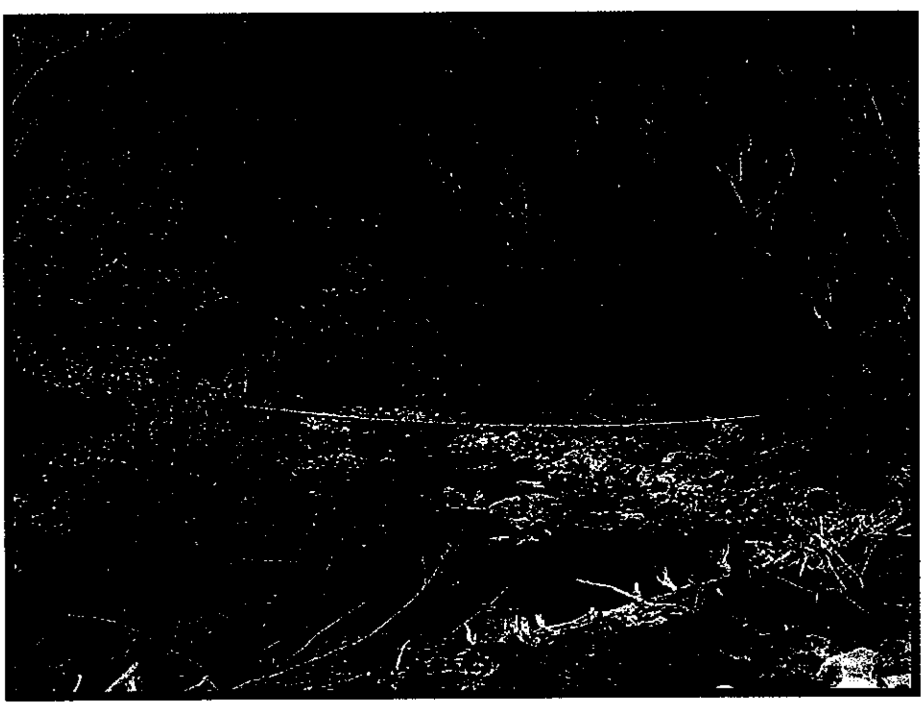


Photo 1-20, looking downstream. Note stable channel margins and bankfull indicators. Map Plate 1a Location: W-18

Channel Width Measurement Locations and Miscellaneous Photo Points—Day 2, November 03, 2001

Photo 2-1, looking downstream. Map Plate 1a Location: W-20

Photo 2-2, looking downstream. Note stable step-pool channel form. Map Plate 1a Location: W-27

Photo 2-3, looking upstream. Note colluvial slope inputs in upper left edge of water. Map Plate 1a Location: W-28

Photo 2-4, looking downstream. Located in restored segment of channel. Map Plate 1a Location: W-29

Photo 2-5, looking downstream. Located in restored segment of channel. Map Plate 1a Location: W-30

Photo 2-6, looking upstream at Pine Creek above confluence with West Fork Jarbidge. Flow estimated at 3 cfs + 1 cfs. Map Plate 1a Location: W-31

Photo 2-7, looking downstream in Pine Creek. Photo point located ~ 600 feet upstream in Pine Creek looking down to West Fork Jarbidge River. Map Plate 1a Location: Pine Creek, upstream of W-31

Photo 2-8, looking downstream toward Pine Creek Campground. Stable section with good bankfull indicators. Map Plate 1a Location: W-32

Photo 2-9, looking upstream. Colluvial slope inputs, left edge of channel. Map Plate 1a Location: W-33

Photo 2-10, looking downstream. Map Plate 1a Location: W-34

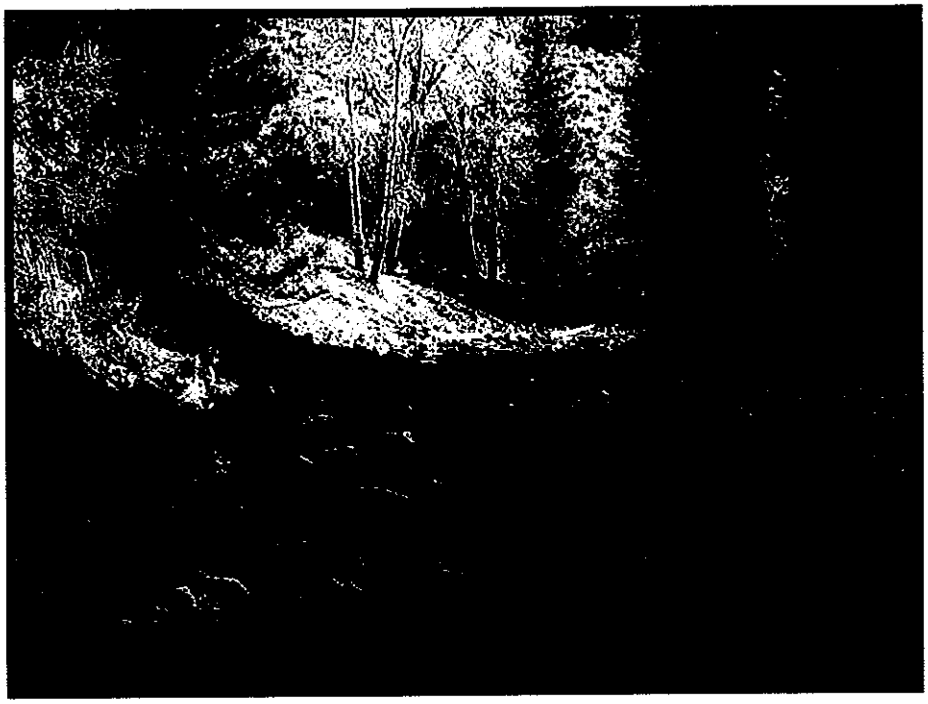


Photo 2-11, looking upstream. Channel incised in debris fan. Road on right edge of water.
Map Plate 1a Location: W-37

Photo 2-12, abandoned mine headworks. Map Plate 1a Location: Mine site near W-37 and W-38

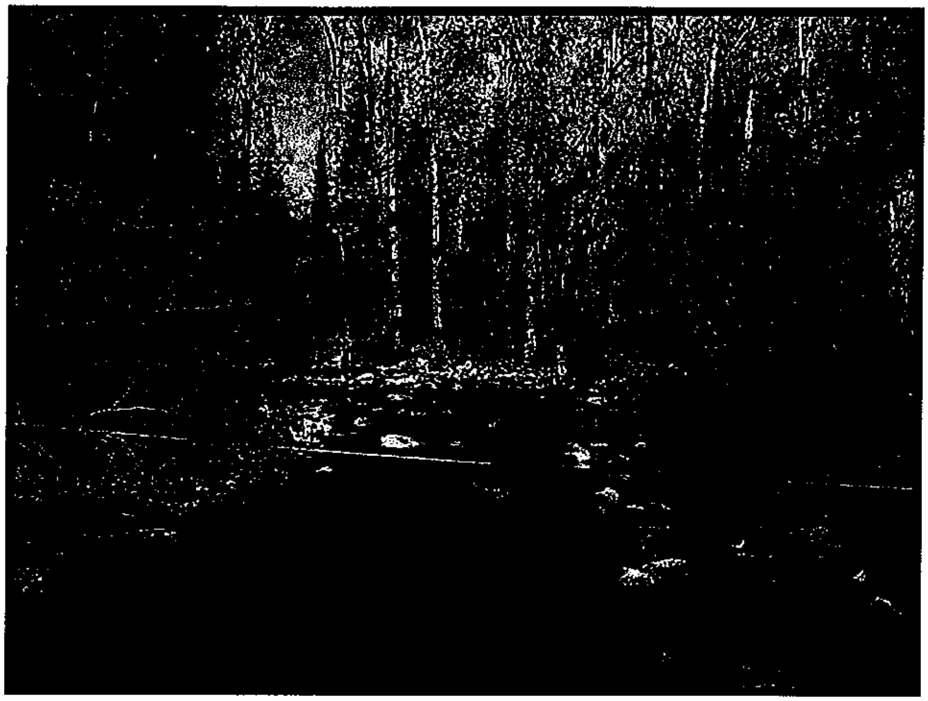


Photo 2-13, looking downstream. Good bankfull indicators. Map Plate 1a Location: W-39

Photo 2-14, looking downstream. In channel depositional zone, high width/depth ratio reach. Map Plate 1a Location: W-42

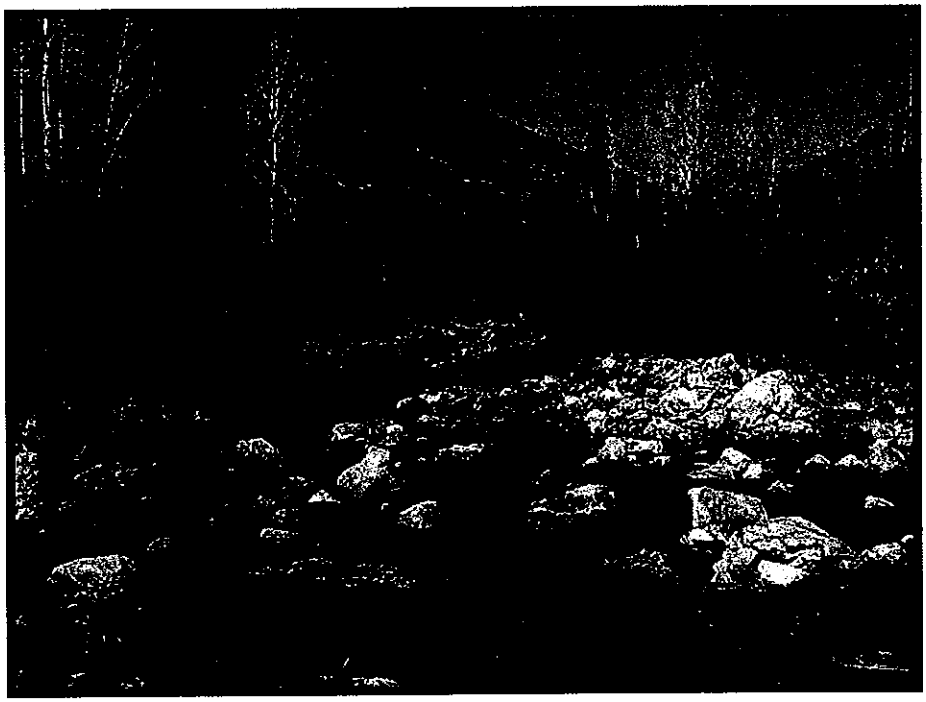


Photo 2-15, looking downstream. Channel bounded by fluvial sediments. Map Plate 1a
Location: W-44

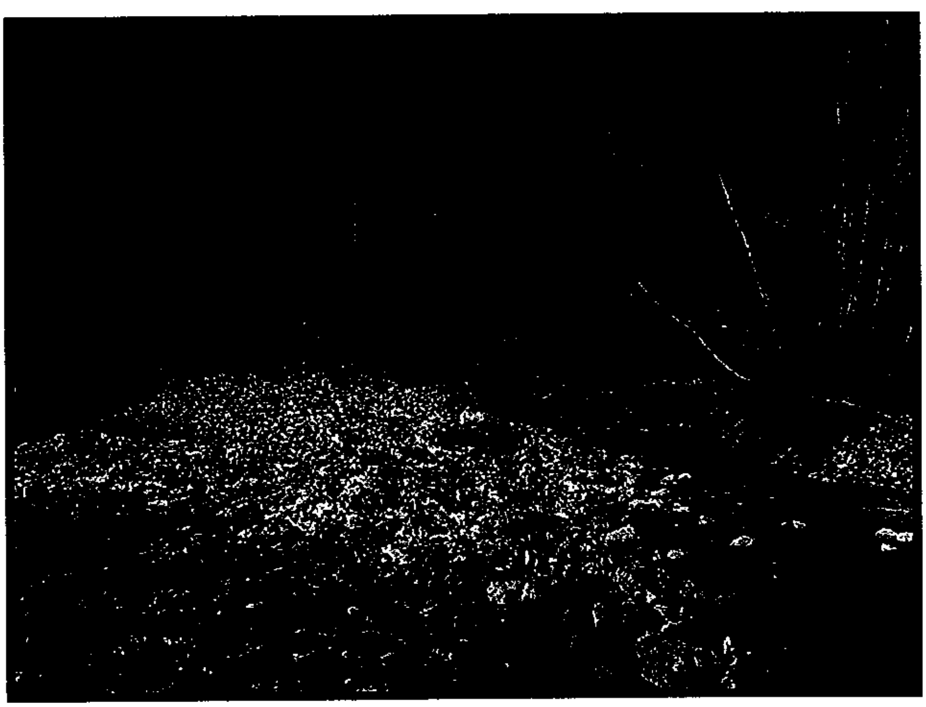


Photo 2-16, looking downstream. Depositional zone, active bar 122 feet wide. Map Plate 1a
Location: W-45

Photo 2-17, looking upstream. Site located on bar downstream of width measurement W-46. Photo shows chute cutoff on inside meander bend terrace and bar zone. Chute cutoff has potential to decrease channel length and increase local channel slope. Map Plate 1a Location: Downstream of W-46

Photo 2-18, looking downstream to Bonanza Gulch campground bridge. Map Plate 1a Location: W-47

Photo 2-19, looking upstream. Map Plate 1a Location: W-48

Photo 2-20, looking downstream. Channel incised in Bonanza Gulch debris fan. Map Plate 1a Location: W-48

Photo 2-21, looking upstream into channel incised into Bonanza Gulch debris fan. Map Plate 1a Location: W-50

Photo 2-22, looking downstream. Good bankfull indicators at section. Map Plate 1a Location: W-56

Photo 2-23, looking downstream. Six to 12 inch diameter Fremont cottonwoods on terrace surface ~ 8 feet above bed of active channel. Map Plate 1a Location: W-58

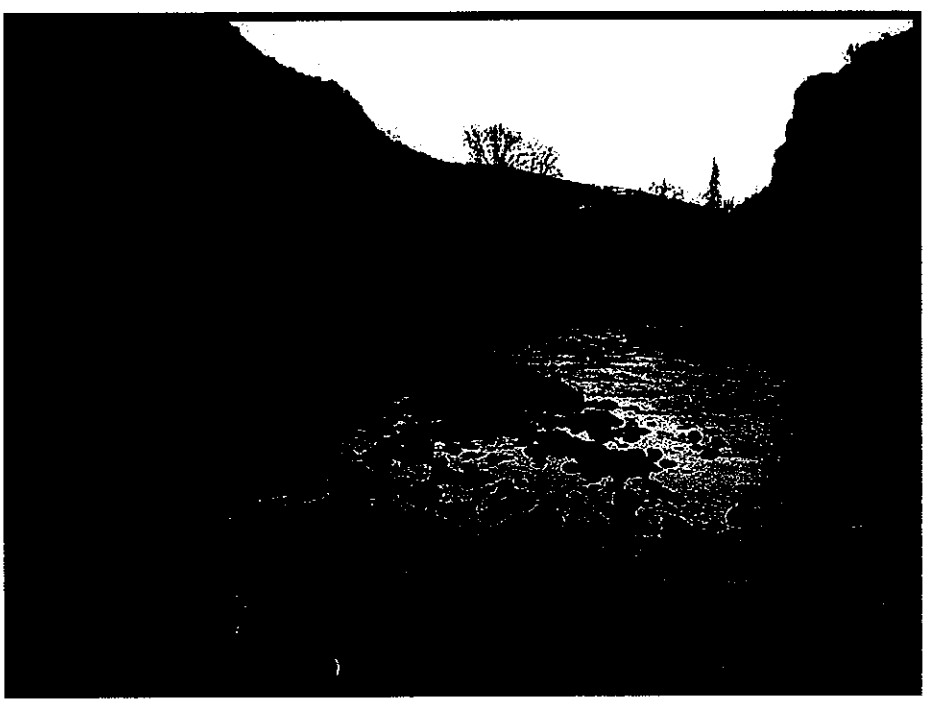


Photo 2-24, looking downstream. Bedrock on channel margins. Map Plate 1a Location: W-60

Photo 2-25, looking downstream at confluence of Bonanza Gulch and West Fork Jarbidge River. Map Plate 1a Location: W-49

Photo 2-26, looking upstream into Bonanza Gulch at width measurement site W-49. Map Plate 1a Location: W-49

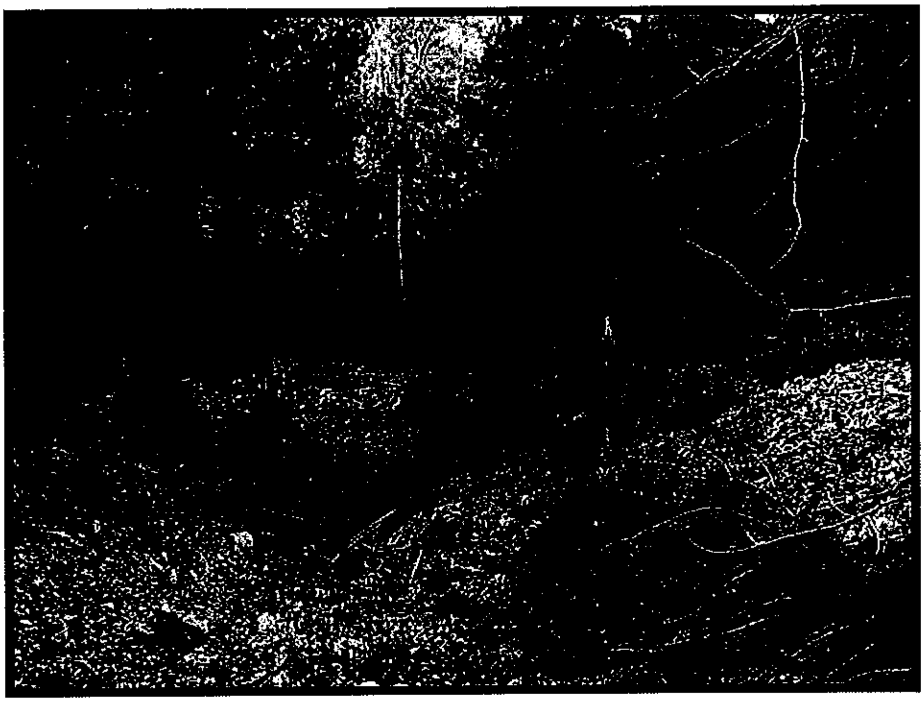


Photo 2-27, looking downstream toward West Fork Jarbidge River from Bonanza Gulch at width measurement site W-49. Map Plate 1a Location: W-49

Channel Width Measurement Locations and Miscellaneous Photo Points—Day 3, November 04, 2001

Photo 3-1, looking downstream. Map Plate 1a Location: W-61

Photo 3-2, looking at right edge of channel. Site located downstream of width measurement site W-61. Photo shows uniform gradation of fluvial surfaces and vegetation away from channel. No evidence for incision in this reach. Map Plate 1a Location: W-61

Photo 3-3, looking at left edge of channel. Photo shows channel cutting into toe slope of talus. Map Plate 1a Location: W-63

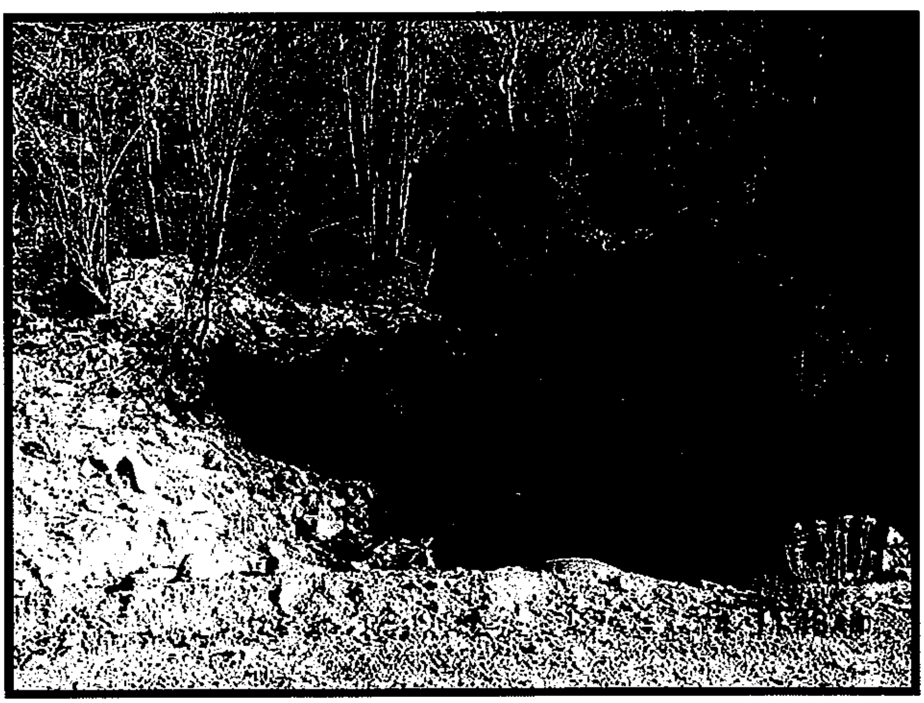


Photo 3-4, looking upstream into Bourne Gulch. Map Plate 1a Location: W-65

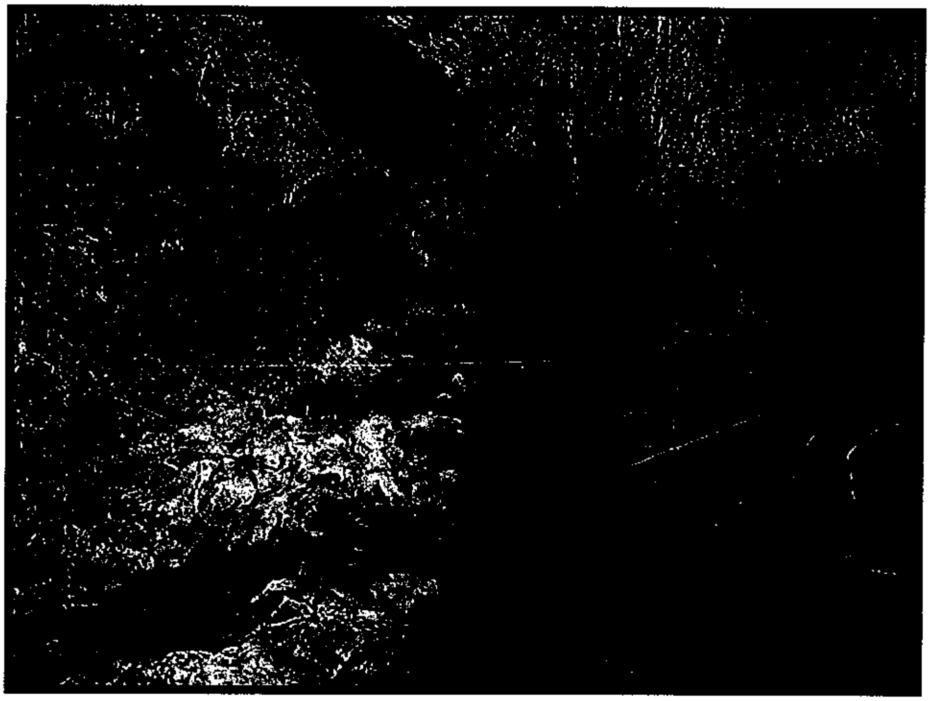


Photo 3-5, looking downstream. Angular coarse substrate from Bourne Gulch. Map Plate 1a Location: W-66

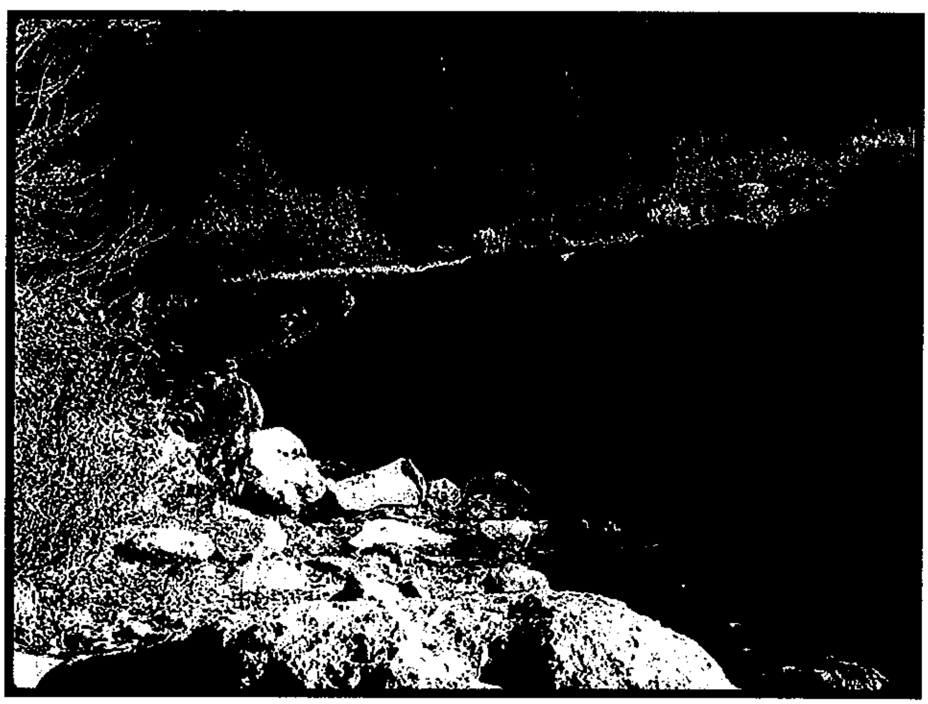


Photo 3-6, looking downstream. Site located downstream of bridge location Br-9. Cut slope contains two sediment units – upper unit 6.5 feet in height, angular, poorly sorted debris or reworked fill. Lower unit 7.5 feet in height, rounded and poorly cemented fluvial gravels. Sediment units separated by burn line with burned timbers. Map Plate 3a Location: BR-9

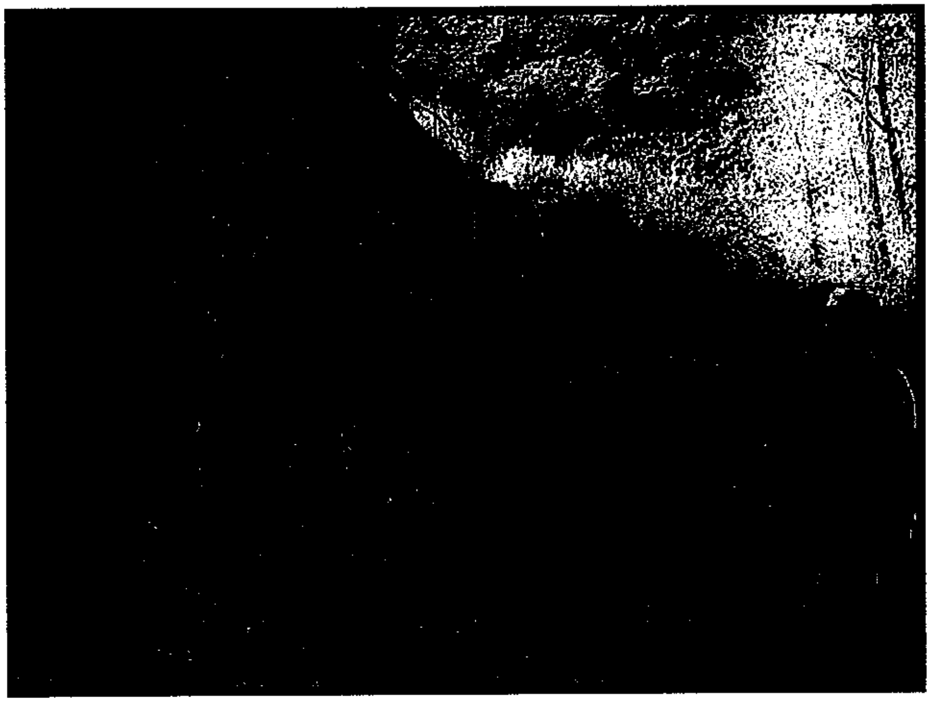


Photo 3-7. Detail of contact described in Photo 3-6. Site located downstream of bridge location Br-9. Note burned debris at tape. Map Plate 3a Location: BR-9

Photo 3-8, looking downstream. Note straight channel alignment and incised channel. Located in reach where historic development of Jarbidge townsite forced channel to right valley margin. Map Plate 1a Location: W-67

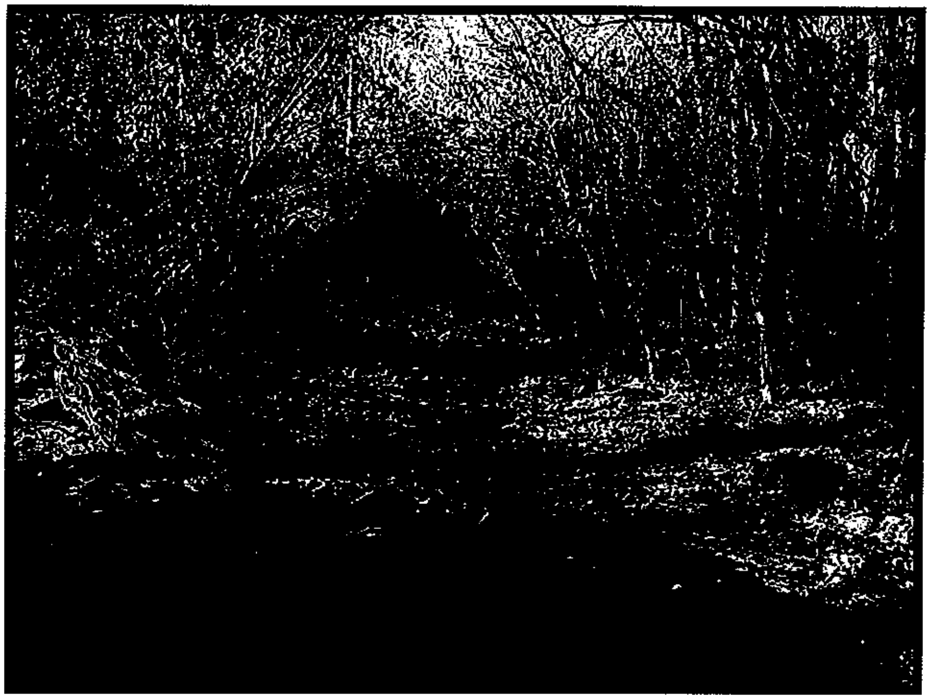


Photo 3-9, looking upstream into Bear Creek from West Fork Jarbidge River. Map Plate 1a
Location: Bear Creek, near W-68

Photo 3-10, looking downstream. Channel has been dredged through this reach. Map Plate 1b
Location: W-71

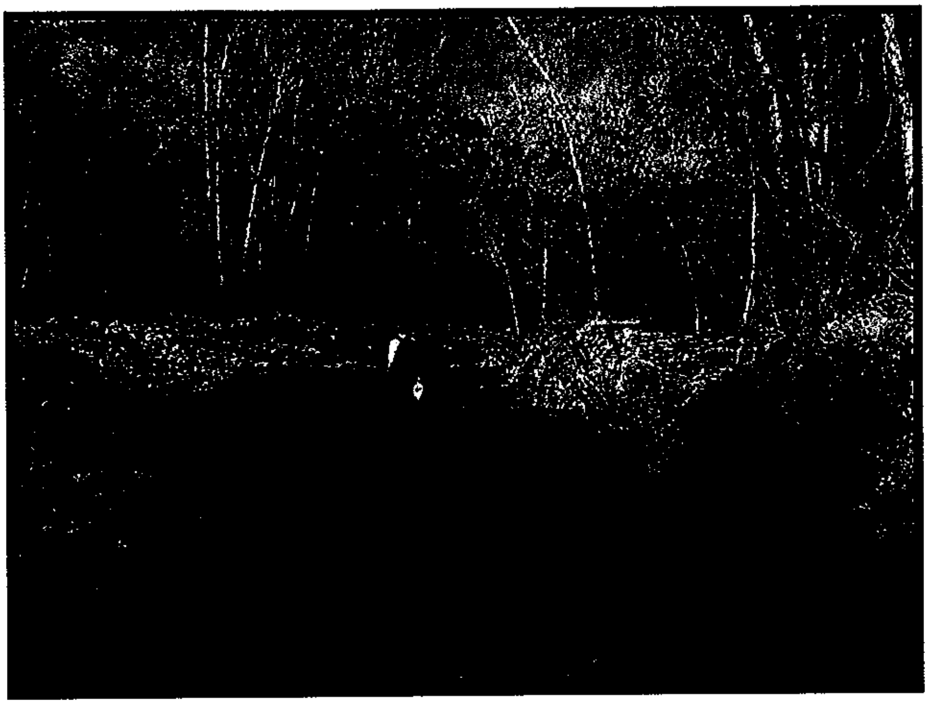


Photo 3-11, looking downstream, at USFS boundary. Note continued staining on rocks. Map Plate 1b Location: W-72

Photo 3-12, looking downstream. Located at distal toe of inactive debris fan. Map Plate 1b Location: W-73

Photo 3-13, looking upstream. Note small inset floodplain between active channel and road prism. Map Plate 1b Location: W-74

Photo 3-14, looking downstream. Note older cottonwoods on channel margins. Map Plate 1b Location: W-75

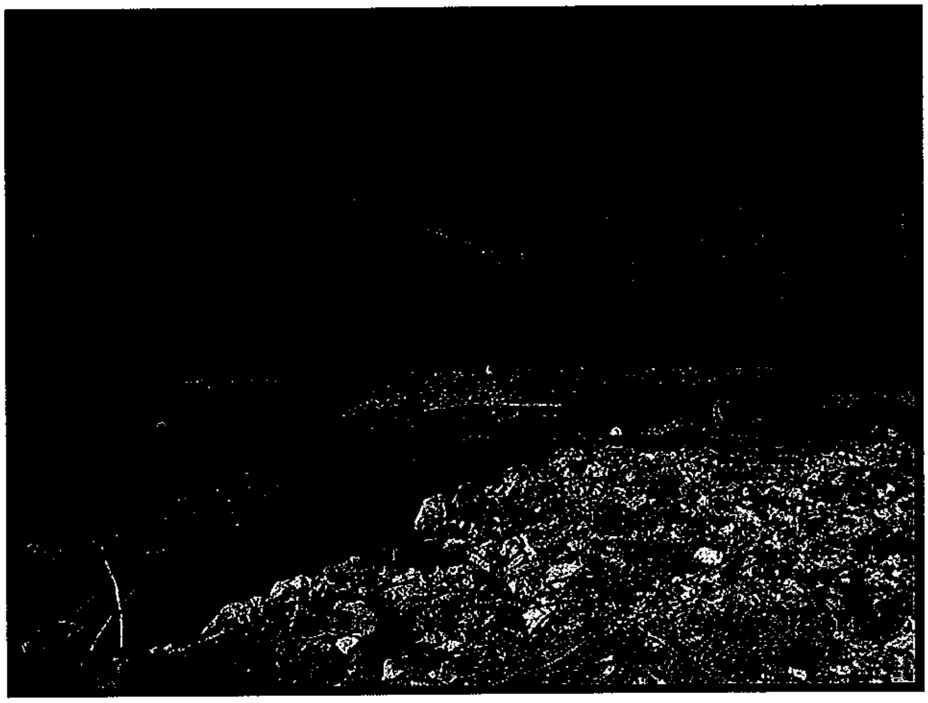


Photo 3-15, looking downstream. Start of depositional reach and sediment storage area. Note braiding and increase in width/depth ratio. Map Plate 1b Location: W-76

Photo 3-16, bar surface at width measurement location W-76. High percentage sands suggest river was transport limited during flood event responsible for bar formation. Map Plate 1b Location: Near W-76

Photo 3-17, looking downstream to USGS gage. Reach has been historically channelized. Map Plate 1b Location: W-77

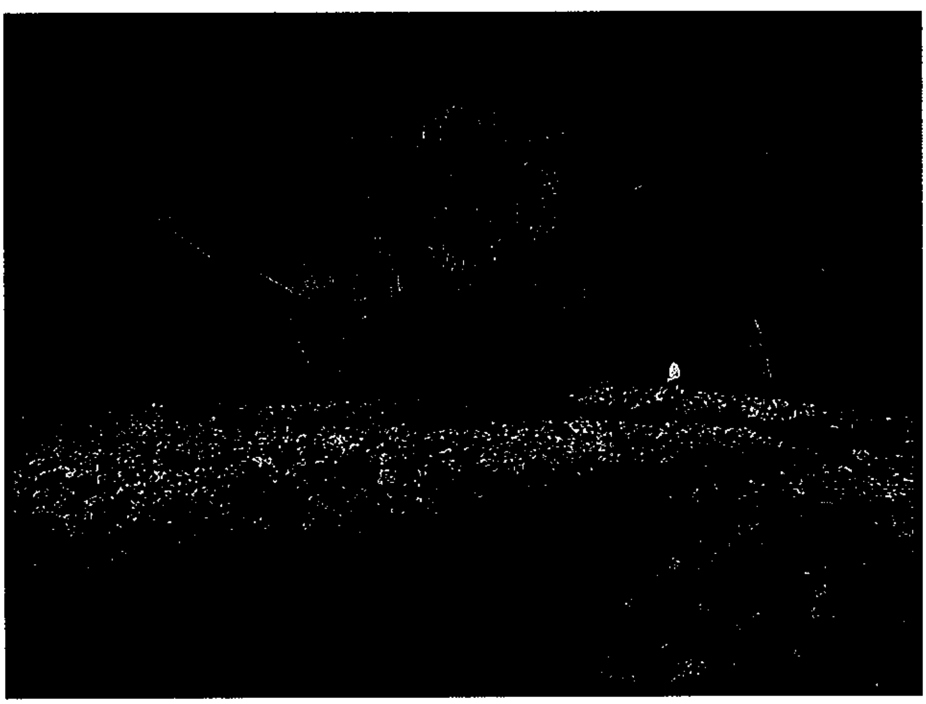


Photo 3-18, looking downstream. Map Plate 1b Location: W-79

Photo 3-19, looking downstream. Map Plate 1b Location: W-80

Photo 3-20, looking downstream. Channel migrating into ~ 15 foot high terrace surface. Fluvial sediment input. Note soil development on surface. Map Plate 1b Location: downstream of W-81

Photo 3-21, looking downstream. Map Plate 1b Location: W-83

Photo 3-22, looking downstream. Map Plate 1b Location: W-85

Photo 3-23, looking downstream. Map Plate 1b Location: W-87

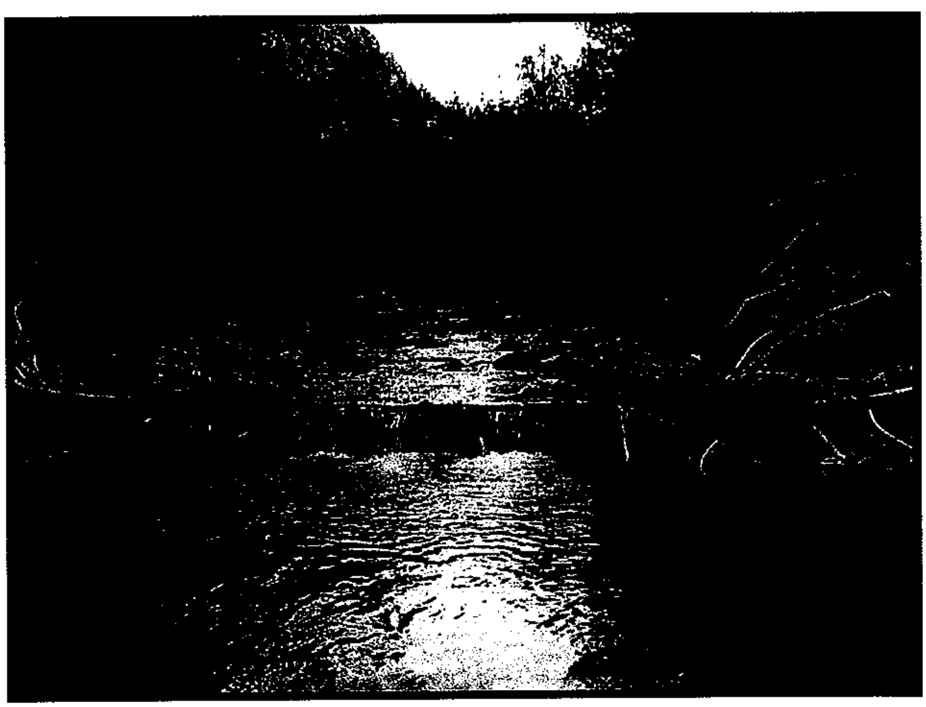


Photo 3-24, looking upstream from location of Photo 3-23. Note sediment storage behind in-channel wood. Map Plate 1b Location: W-87

Photo 3-25, looking upstream into Jack Creek from West Fork Jarbidge River. Map Plate 1b Location: Near W-88

Photo 3-26, looking downstream. Map Plate 1b Location: W-89

Photo Log—Bridge and Crossing Structures

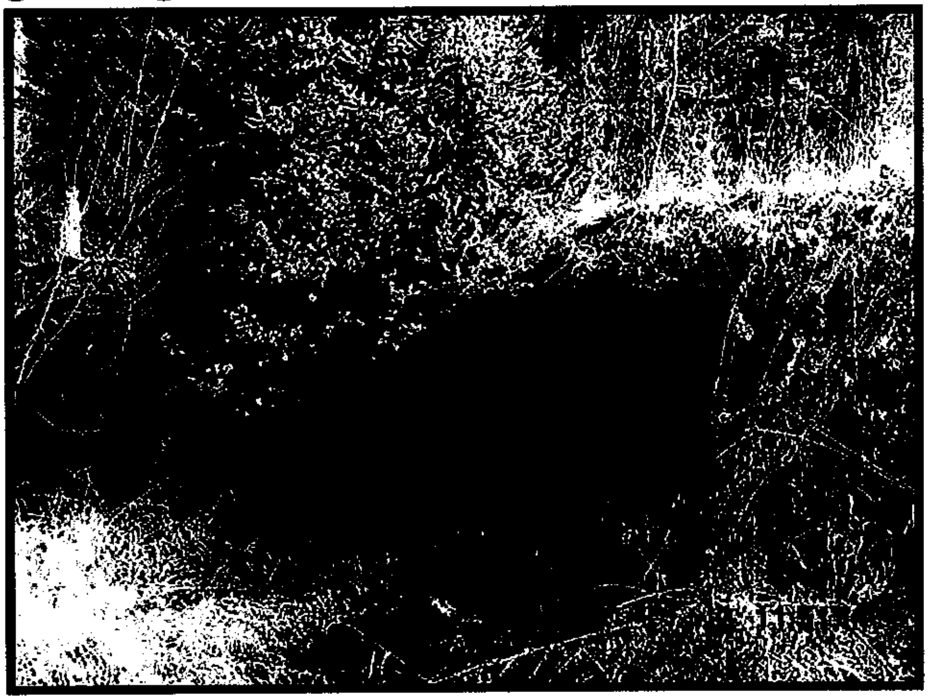


Photo B-1, looking at outlet. Location Br-1. Crossing failure estimated over 30 years old. Current channel at same elevation as culvert invert. Map Plate 5a Location: BR-1

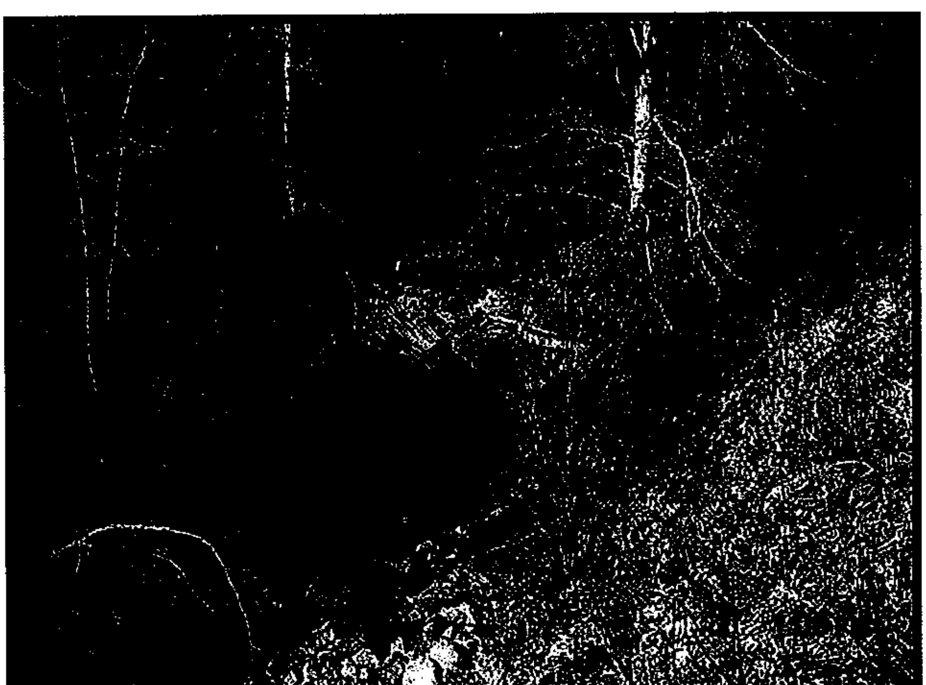


Photo B-2, looking downstream to failed crossing structure. Location Br-2. Map Plate 5a Location: BR-2

Photo B-3, looking upstream. Location Br-2. Map Plate 5a Location: BR-3

Photo B-4, looking downstream to location Br-3. Map Plate 5a Location: BR-3

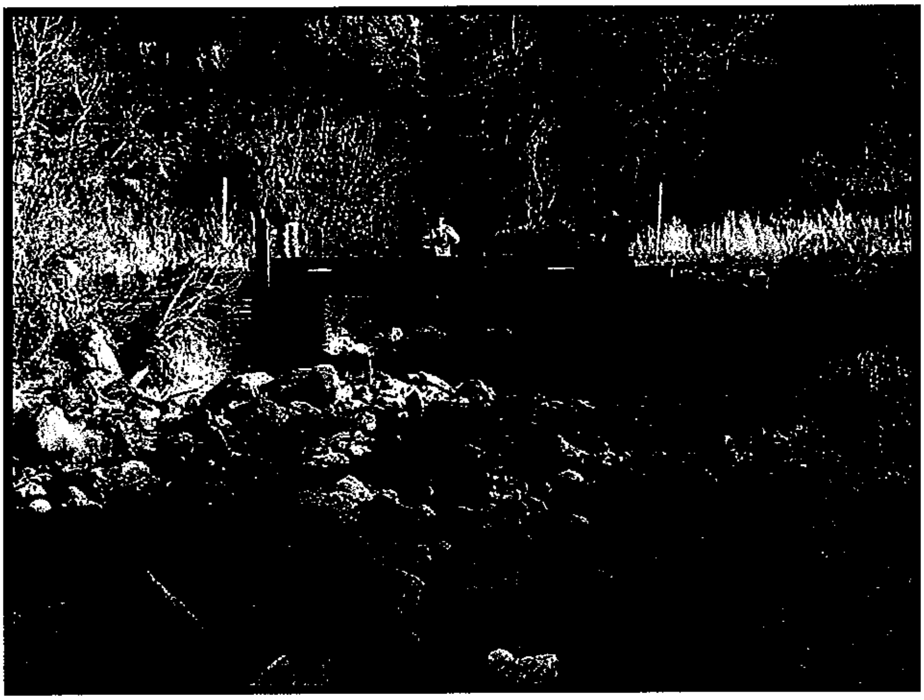


Photo B-5, looking downstream to location Br-3. Map Plate 5a Location: BR-3

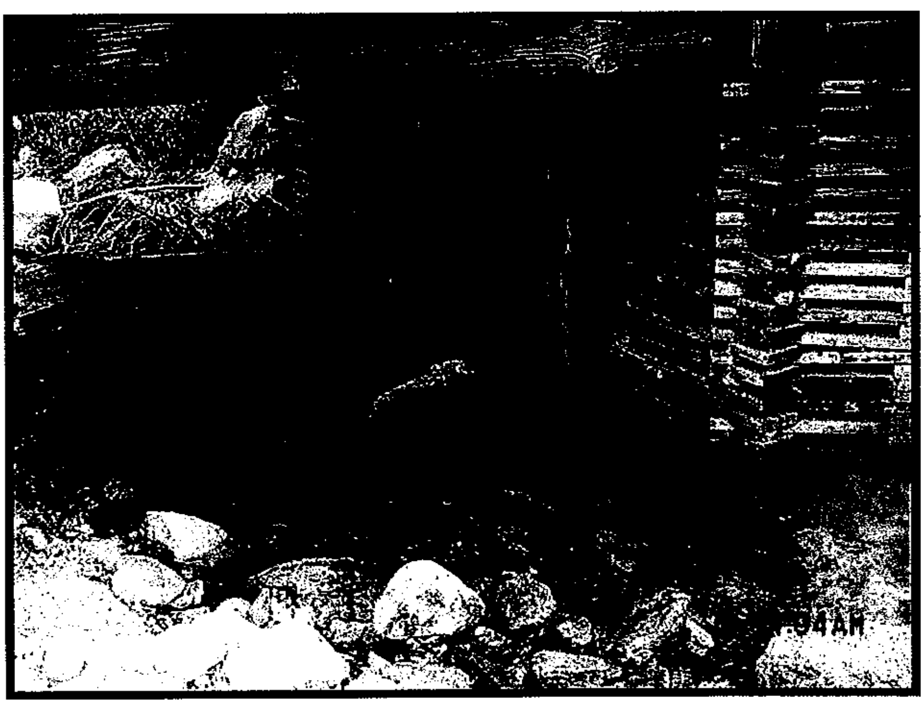


Photo B-6, right abutment. Location Br-3. Map Plate 5a Location: BR-3

Photo B-7, left abutment. Location Br-3. Map Plate 5a Location: BR-3

Photo B-8, looking upstream to location Br-3. Map Plate 5a Location: BR-3

Photo B-9, looking downstream. Site location Br-4. Road captured upstream of bridge and active channel bypasses bridge opening. Map Plate 5a Location: BR-3

Photo B-10, looking downstream. Site location Br-4. Active channel to left of bridge, see Photo B-9.

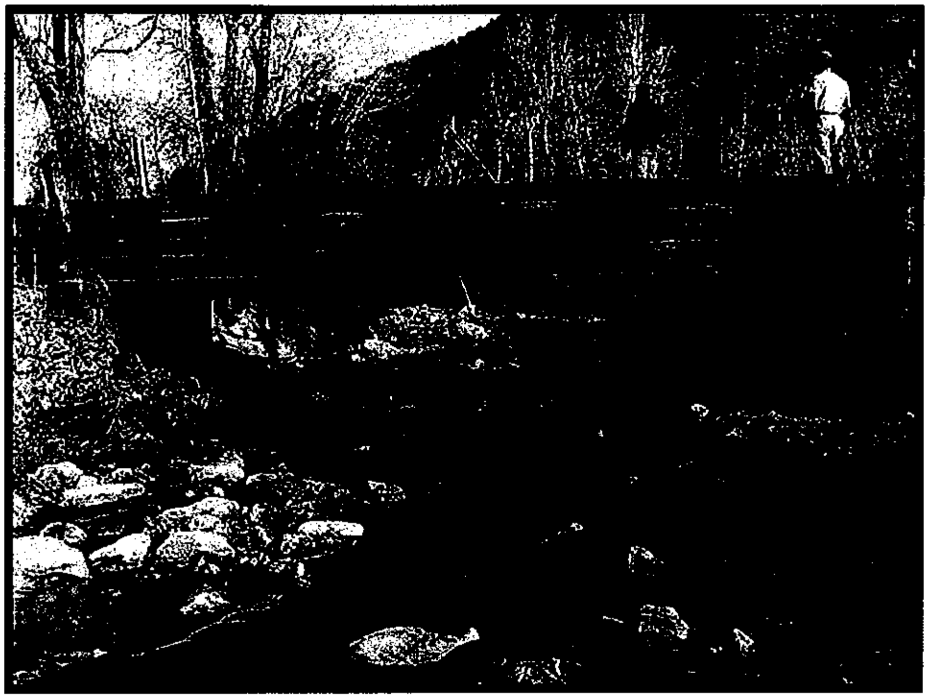


Photo B-11, looking downstream. Site location Br-5. Note gabions at left abutment.

Photo B-12, left abutment. Location Br-5.

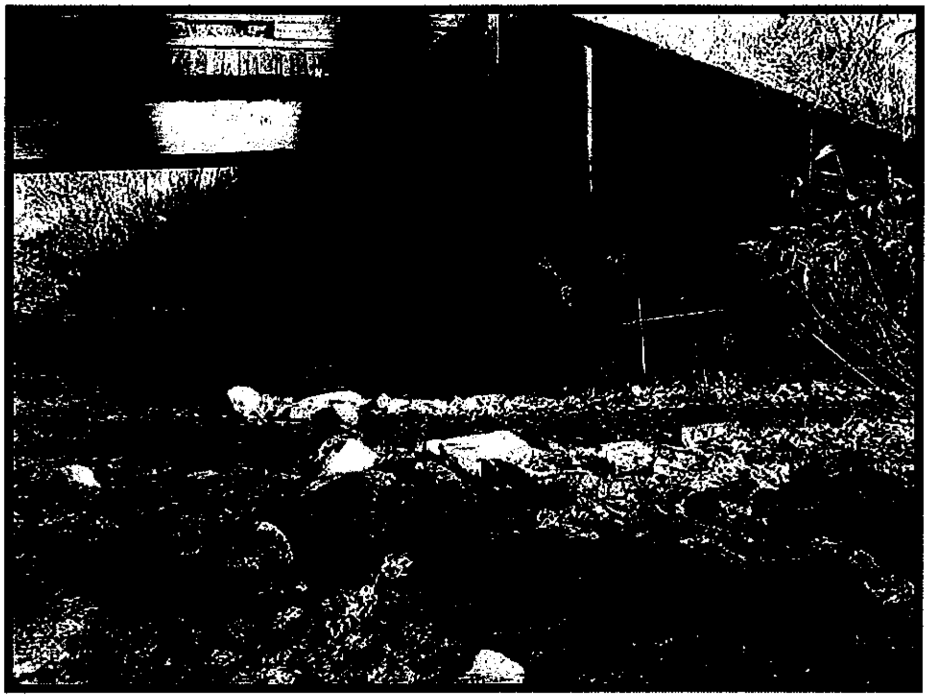


Photo B-13, right abutment. Location Br-5.

Photo B-14, looking downstream from bridge deck. Location Br-5.

Photo B-15, looking downstream. Location Br-6.

Photo B-16, left abutment. Location Br-6.

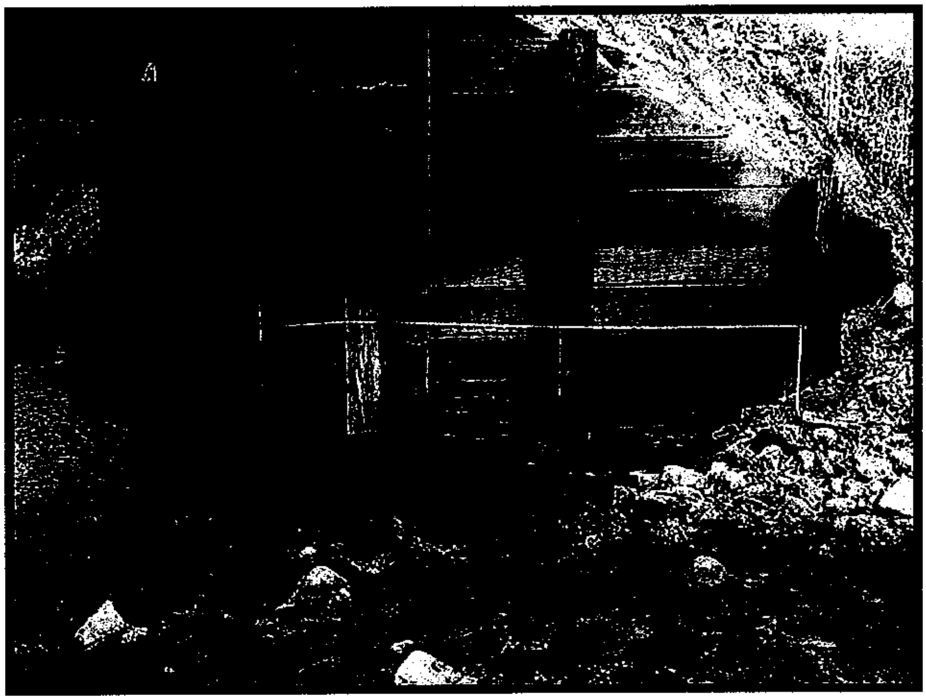


Photo B-17, right abutment. Location Br-6.

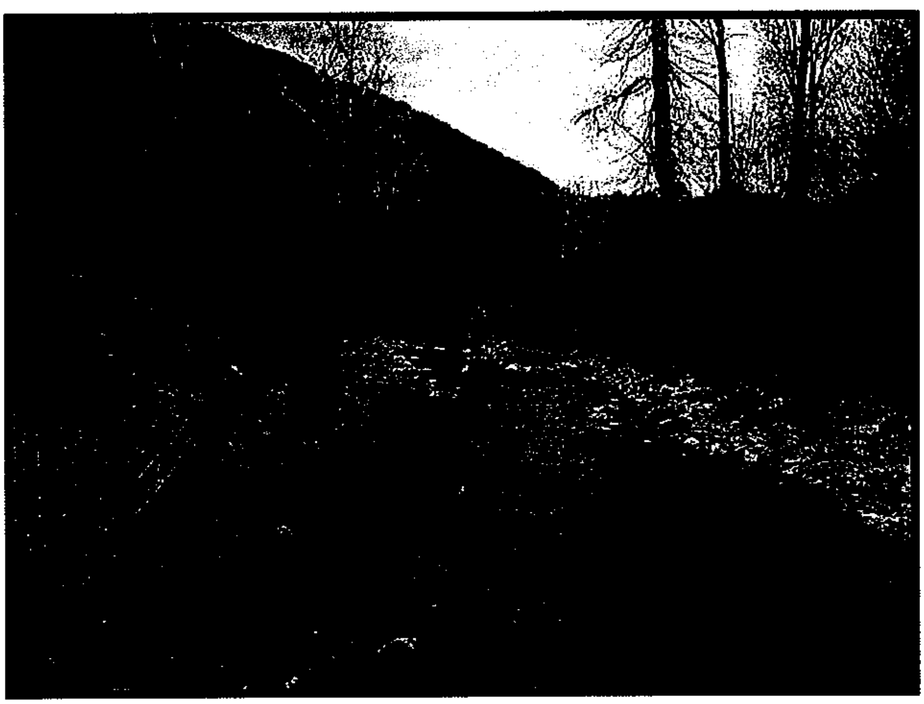


Photo B-18, looking downstream from bridge deck. Location Br-6.

Photo B-19, looking downstream. Location Br-7.

Photo B-20, left abutment. Location Br-7.

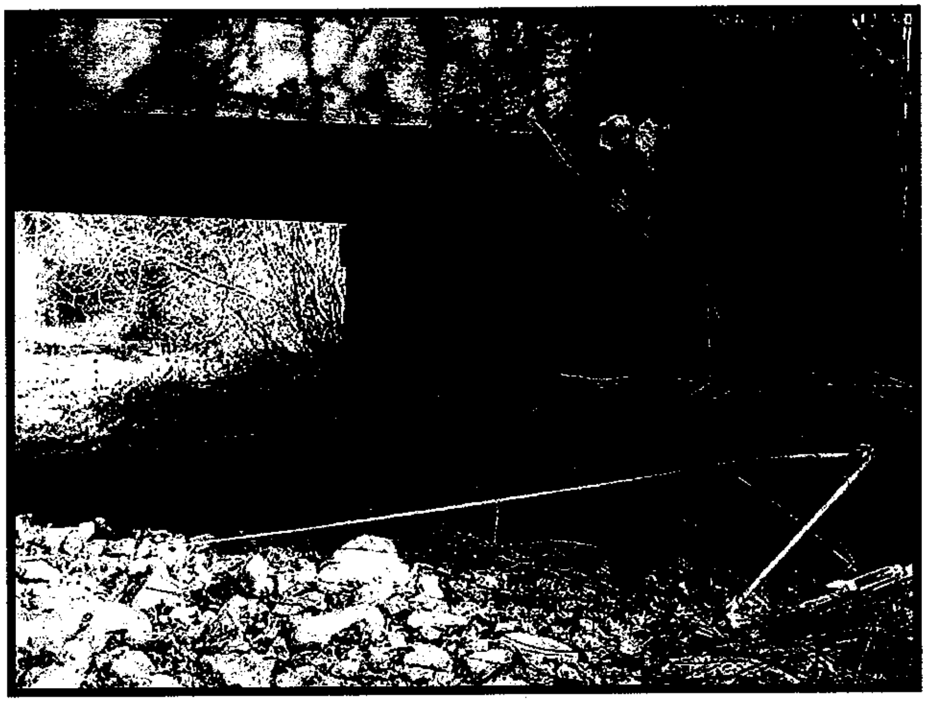


Photo B-21, right abutment. Location Br-7.

Photo B-22. Location Br-7. Note chronic sediment source under guard rails.

Photo B-23, looking downstream from bridge deck. Location Br-7.

Photo B-24, looking downstream. Location Br-8. Note elevated bar upstream of bridge opening.

Photo B-25, looking downstream. Location Br-8.

Photo B-26, left abutment. Location Br-8.

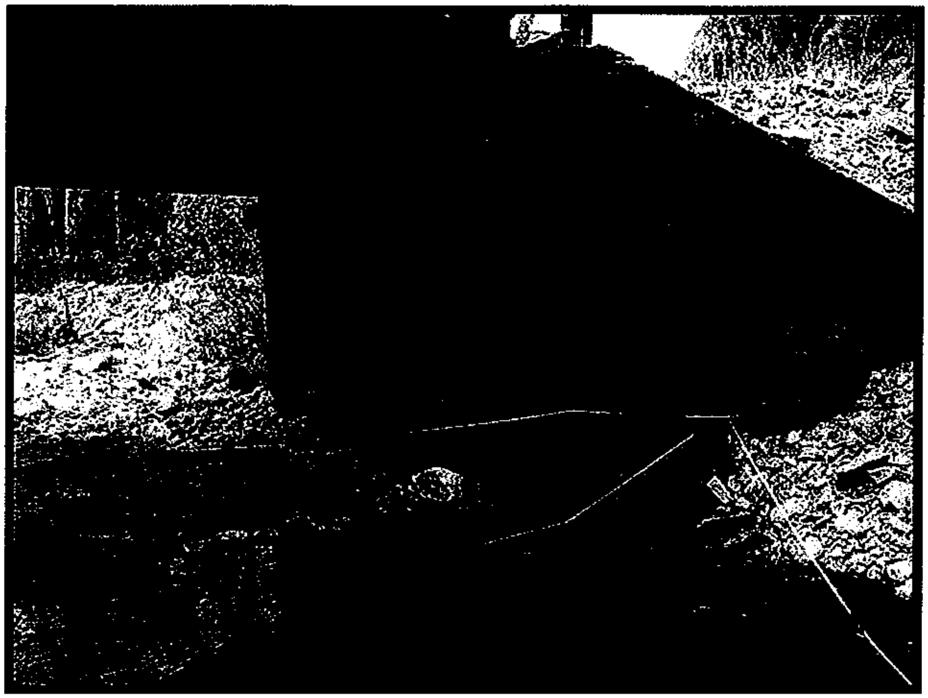


Photo B-27, right abutment. Location Br-8.

Photo B-28, looking downstream from bridge deck. Location Br-8.

Photo B-29, looking downstream. Location Br-9. Note failing fill at left abutment.

Photo B-30. Location Br-9. Failing fill at left abutment.

Photo B-31, left abutment. Location Br-9.

Photo B-32, right abutment. Location Br-9.

Photo B-33, looking downstream from bridge deck. Location BR-9.

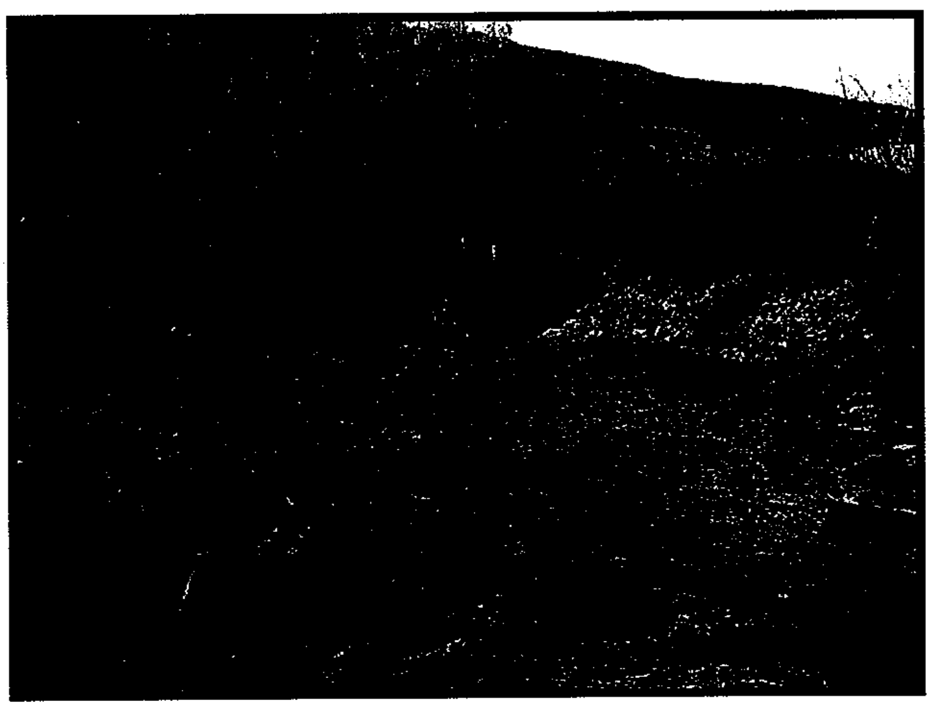


Photo B-34, looking downstream to bridge. Location Br-10.

Photo B-35, left abutment. Location Br-10.

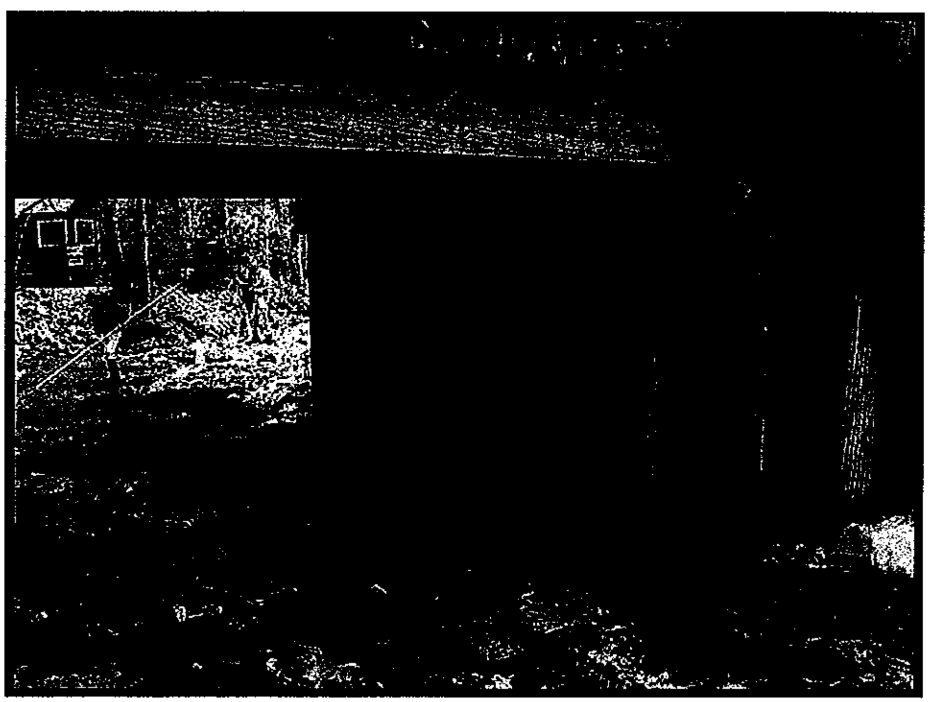


Photo B-36, right abutment. Location Br-10.

Photo B-37, looking downstream of bridge. Location Br-10.

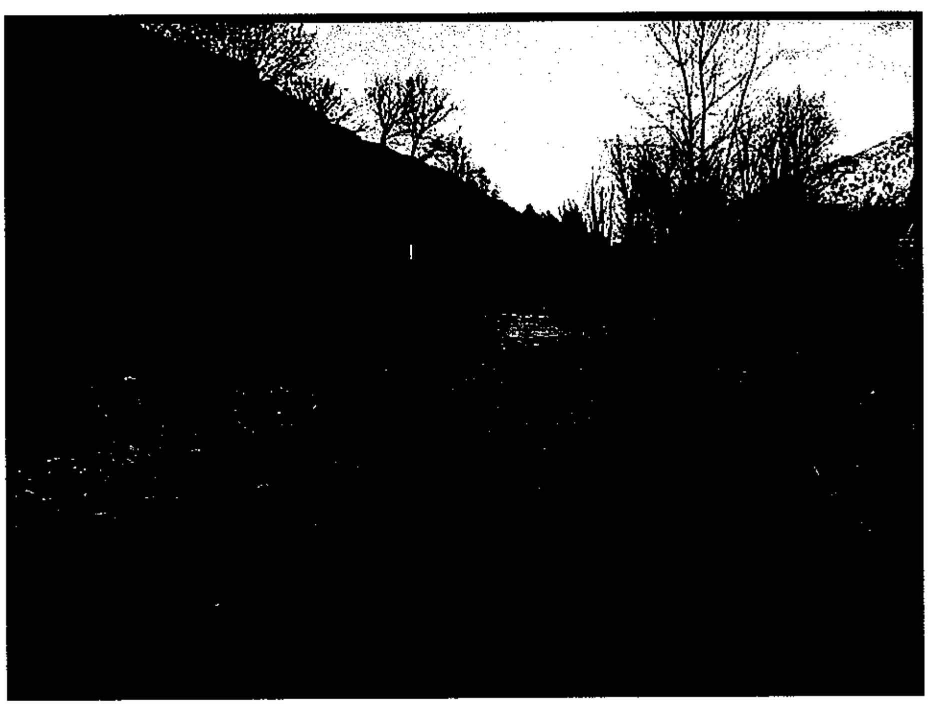


Photo B-38, looking downstream to bridge. Location Br-11.

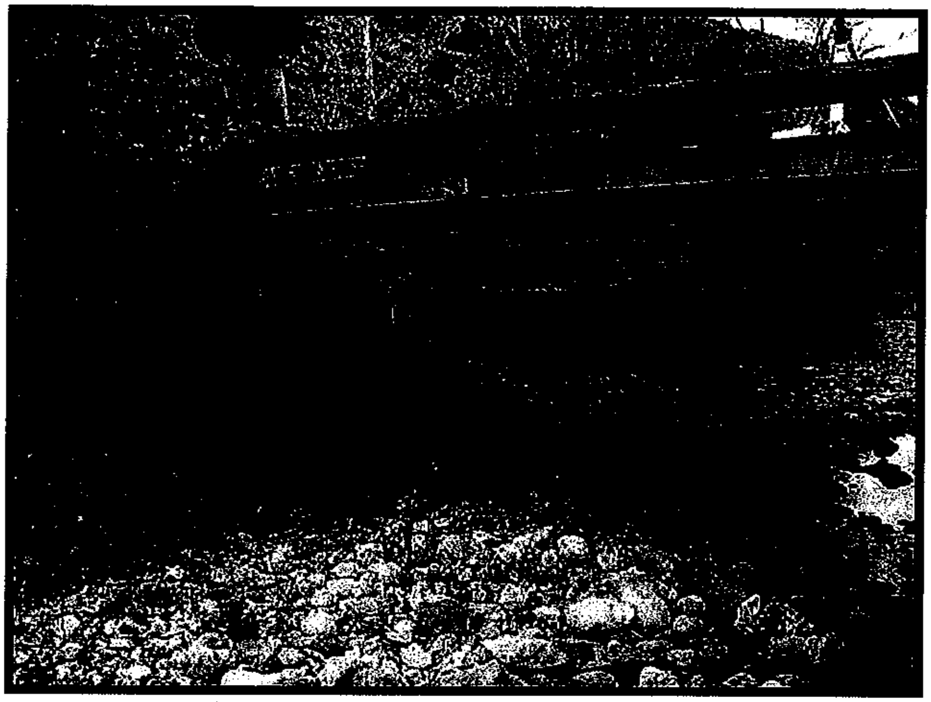


Photo B-39, left abutment. Location Br-11.

Photo B-40, right abutment. Location Br-11.

Photo B-41, looking downstream from bridge deck. Location Br-11.

Photo B-42, looking downstream. Flatbed car bridge located downstream of width measurement W-53.

Photo B-43, looking downstream. Failed crossing on Jack Creek upstream of confluence with West Fork Jarbidge River.

Photo Log—Road and Channel Interaction

Photo R-1, looking downstream. Channel migrating into road prism. Note large wood inputs where roadside vegetation undermined. Map Plate 4a Location: R-1

Photo R-2, looking downstream in lower part Pine Creek Campground. Campground road encroaching on channel in lower right part of photo. Map Plate 4a Location: R-2

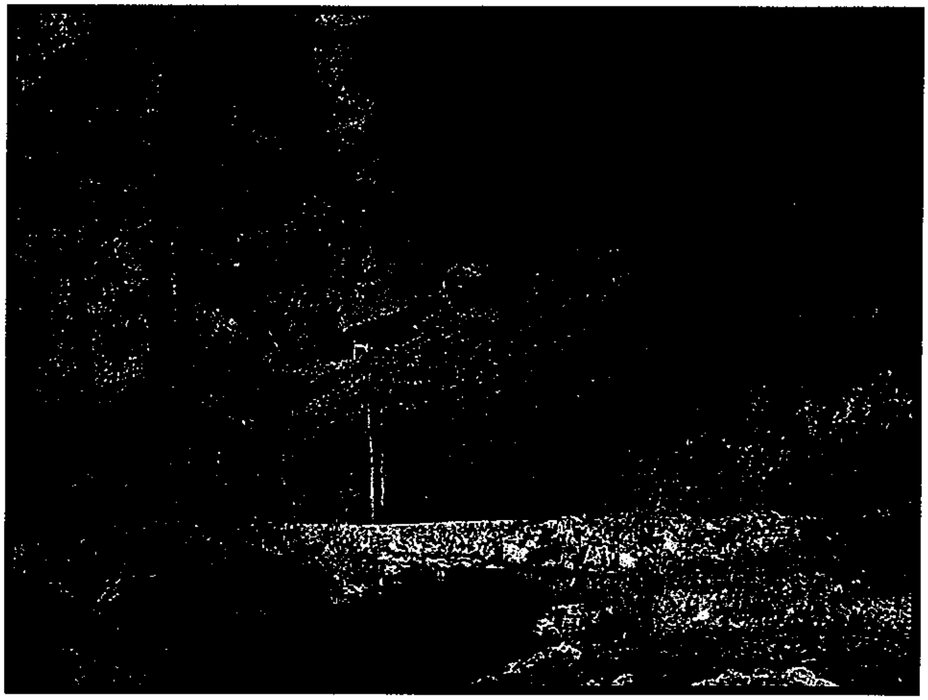


Photo R-3, looking downstream. Site located upstream of width measurement W-35. Map Plate 4a Location: R-3, between R-2 and R-4

Photo R-4, looking downstream. Site located at width measurement W-35. Channel migrating into toe of road fill slope, requiring road-bed armouring. Map Plate 4a Location: R-4

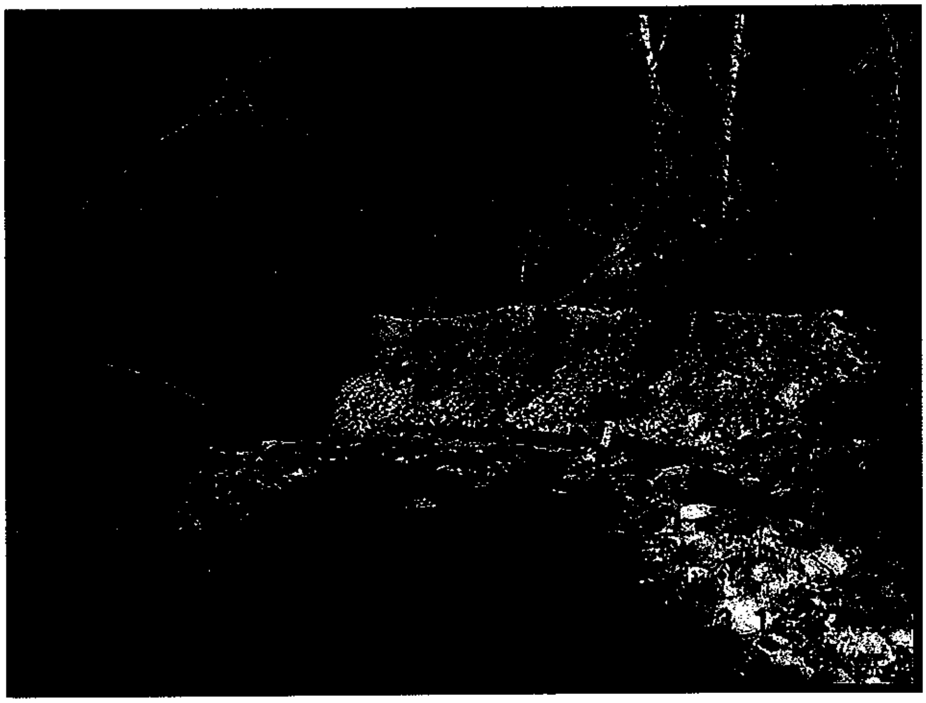


Photo R-5, looking downstream. Site located at width measurement W-36. Channel incised into debris fan. Road also located on toe of fan and sediment inputs to channel related to debris fan and road prism. Map Plate 4a Location: R-5

Photo R-6, looking downstream. Site located at width measurement W-52. Channel migrating into road prism. Map Plate 4a Location: R-6

Photo R-7, looking downstream. Site located upstream of width measurement W-57. Channel migrating into road segment cut into toe of colluvial slope. Map Plate 4a Location: R-7

Photo R-8, looking downstream. Site located at width measurement W-57. Channel migrating into road segment. Sidecasting during road maintenance direct sediment source. Map Plate 4a Location: R-8

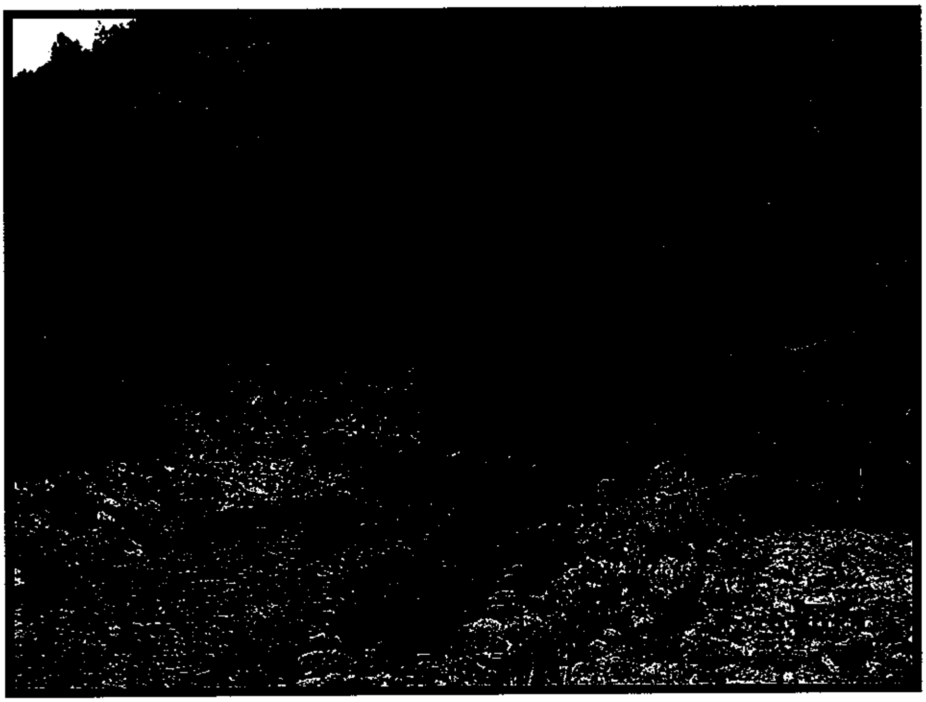


Photo R-9, looking downstream. Site located downstream of measurement site W-83. Channel migrating into road prism. Map Plate 4a Location: R-9

Photo R-10, looking downstream. Road adjacent to channel. Road bench has oversteepened upper cut slope accelerating slope erosion. Note light textured material is ash layer. Map Plate 4a Location: R-10

Photo R-11, looking downstream. Road maintenance is a chronic sediment source at this site. Map Plate 4a Location: R-11

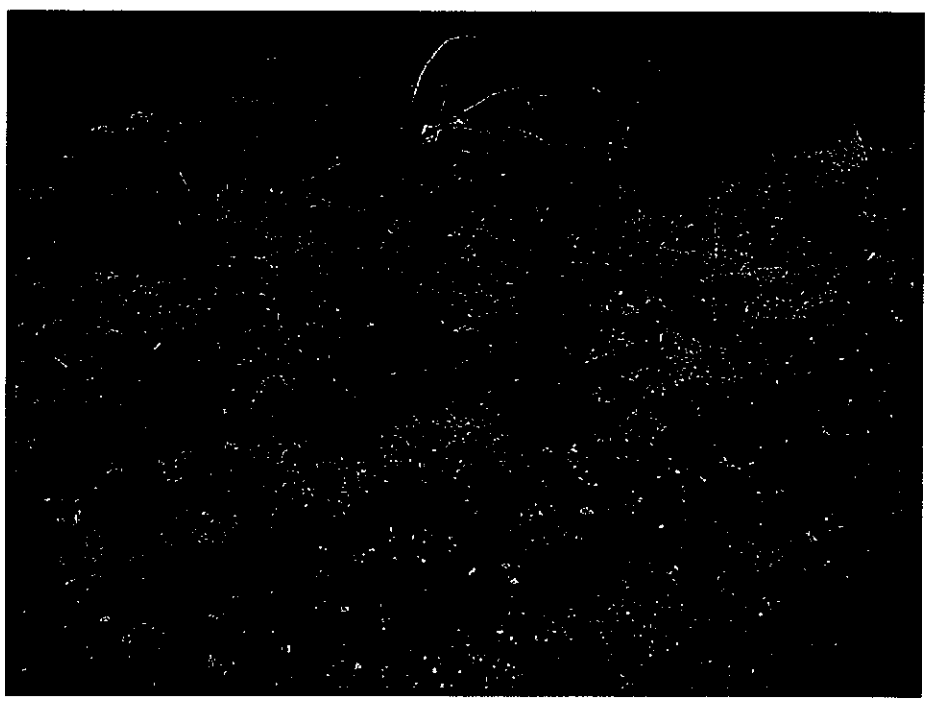


Photo R-12. Site located downstream of width measurement location W-86. Road drainage is forming a rill and routing flow to West Fork Jarbidge River. Map Plate 4a Location: R-12

Survey Reach Locations

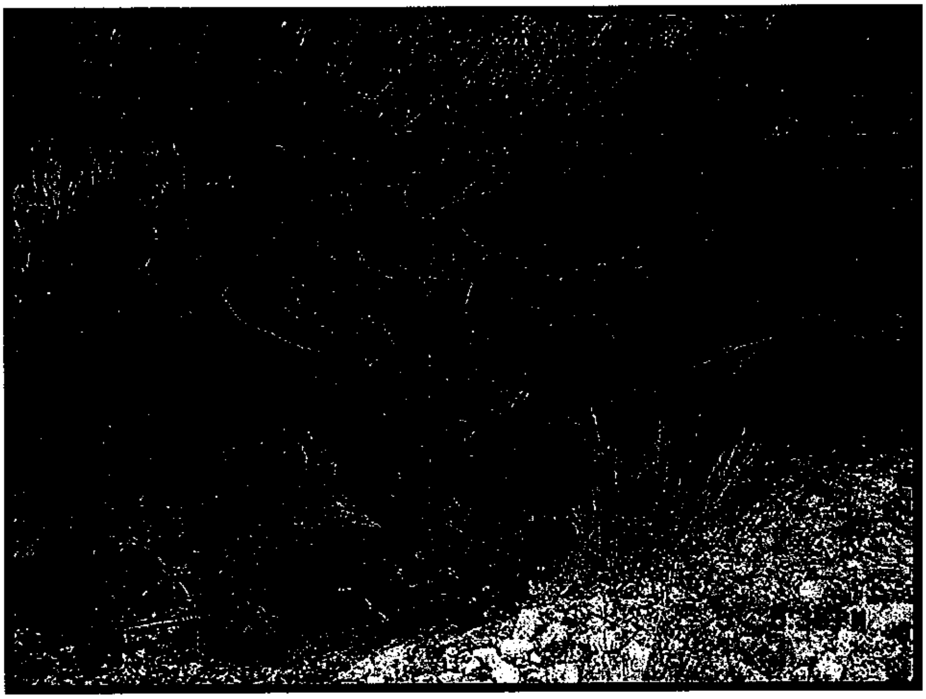


Photo S-1. Location USGS gage at Br-11. Note bankfull indicator at floodplain elevation. Map Plate 5b Location: BR-11

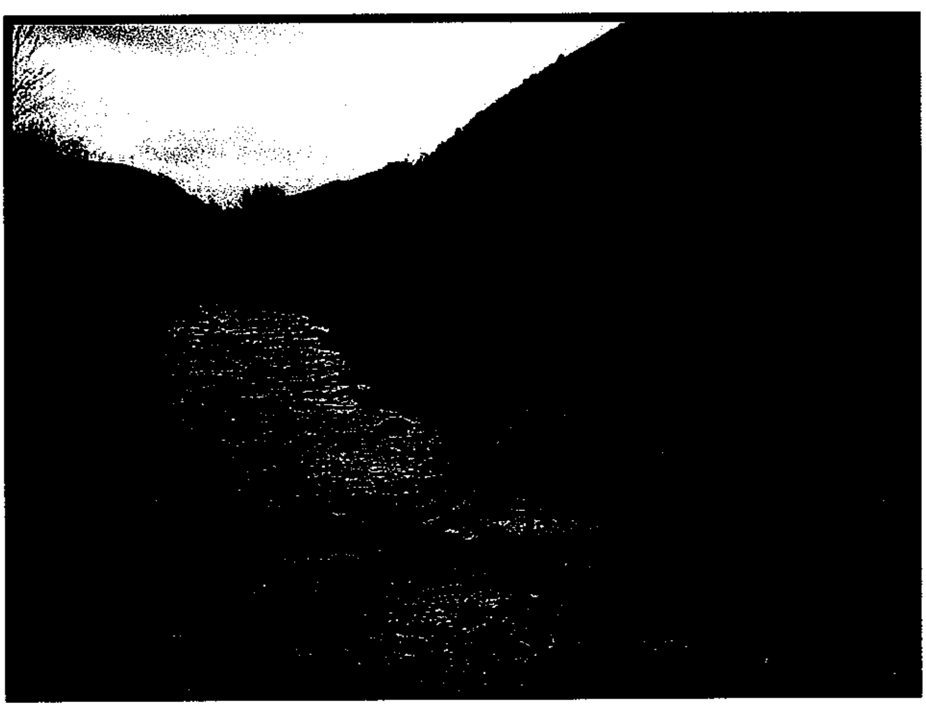


Photo S-2. Location upstream of USGS gage at Br-11. Break in slope on left edge of water surveyed as bankfull water surface slope. Map Plate 5b Location: BR-11

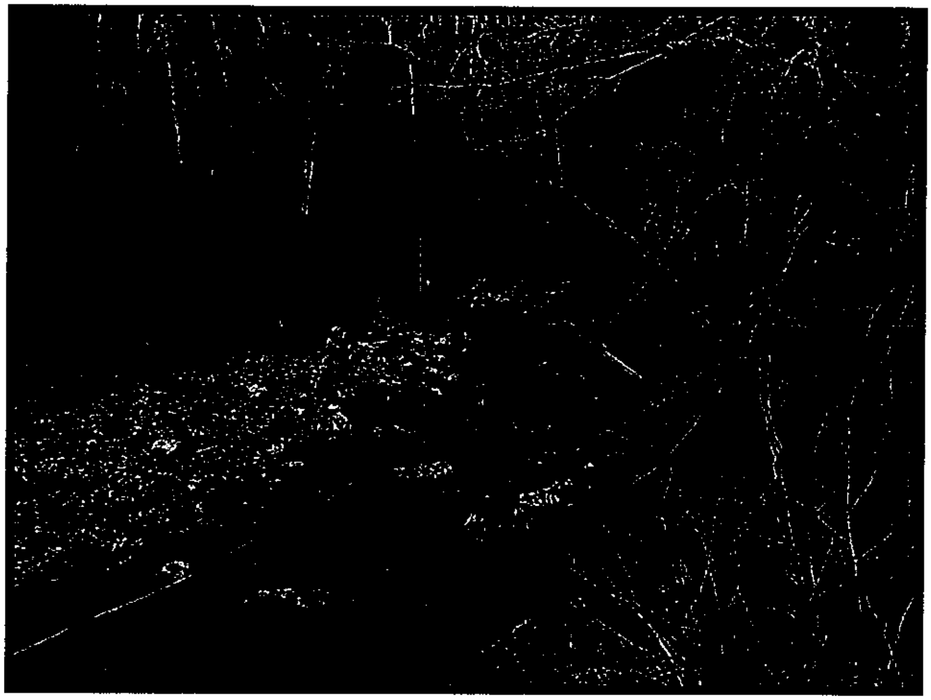


Photo S-3, looking downstream through Pine Creek survey reach. Map Plate 1a Location: W-31, W-32

Photo S-4, looking downstream. Cross section survey location, Pine Creek survey reach. Map Plate 1a Location: W-31, W-32

Photo S-5, looking at fluvial surfaces on left edge of channel. Location Pine Creek survey reach. Note progression of vegetation age from floodplain to terrace surface one. Map Plate 1a Location: W-31, W-32

Photo S-6, looking downstream through Bonanza Gulch survey reach. Map Plate 1a Location: W-48 -51

Photo S-7, looking downstream. Breached woody debris dam in Bonanza Gulch survey reach. Due to steep unstable banks, channel segments located in debris fans are primary sources of wood recruitment to channel. Map Plate 1a Location: W-48 -51

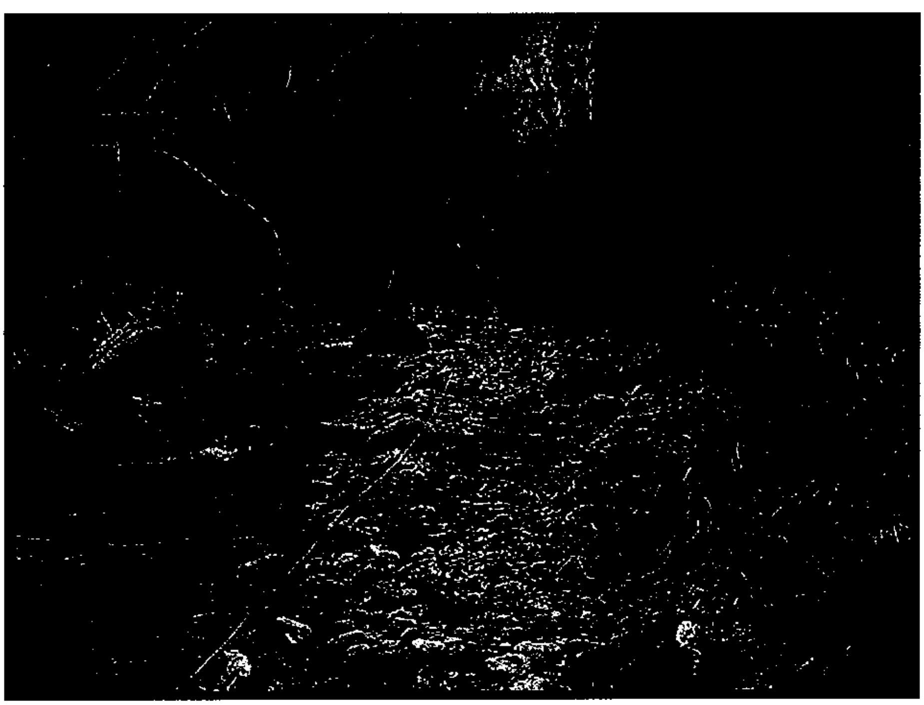


Photo S-8, looking upstream from downstream extent of Bonanza Gulch survey reach. Map Plate 1a Location: W-51

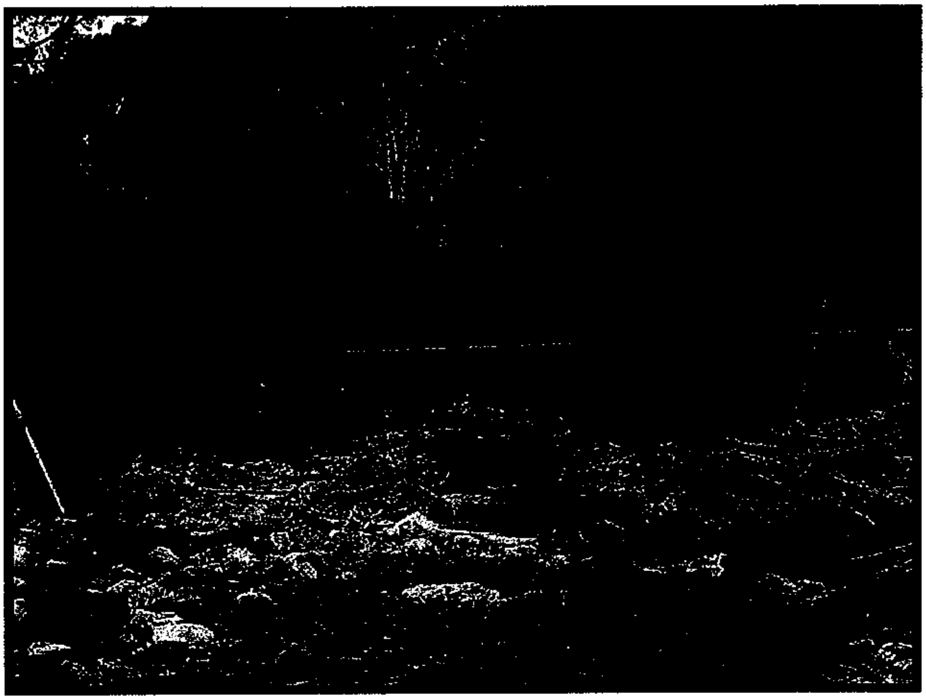


Photo S-9, looking downstream. Cross section one, located downstream in Bonanza Gulch survey reach. Map Plate 1a Location: W-51

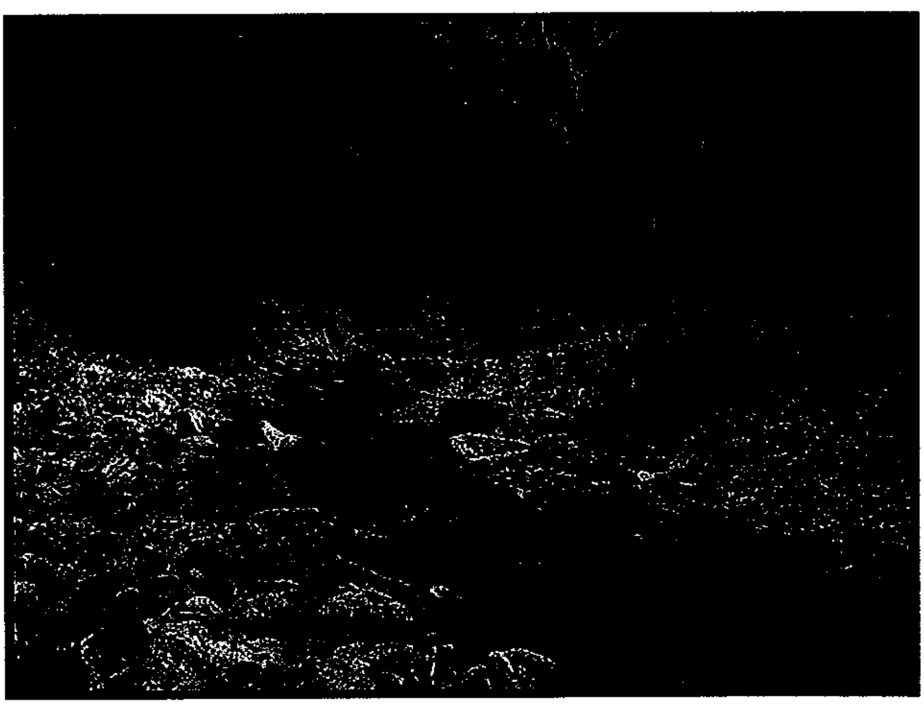


Photo S-10, looking downstream. Cross section 2 located in upstream part of Bonanza Gulch survey reach. Map Plate 1a Location: W-48

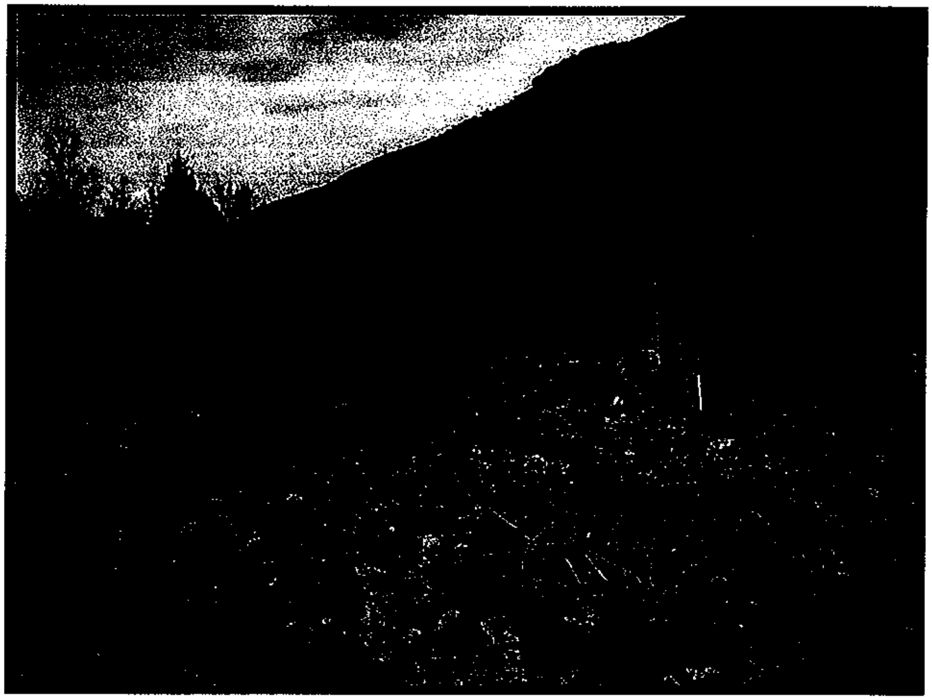


Photo S-11. Looking downstream through Mahoney Guard Station survey reach. Map Plate 1b Location: W-78

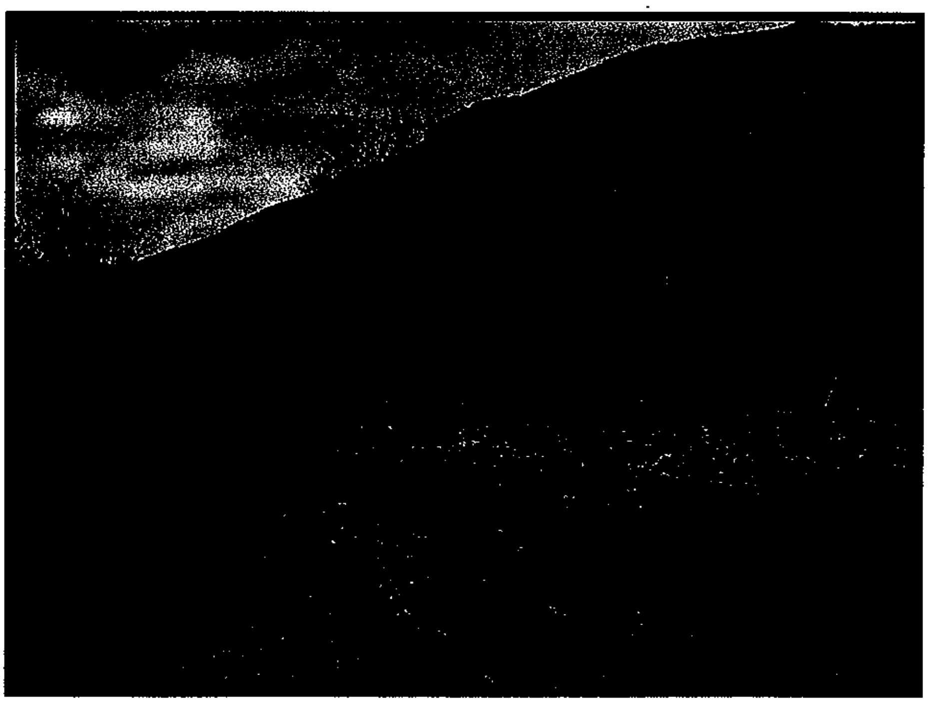


Photo S-12, looking downstream. Looking at cross section 1, Mahoney Guard Station survey reach. Map Plate 1b Location: W-78

Photo S-13, looking downstream. Location Jack Creek survey reach. Map Plate 1b Location: W-87

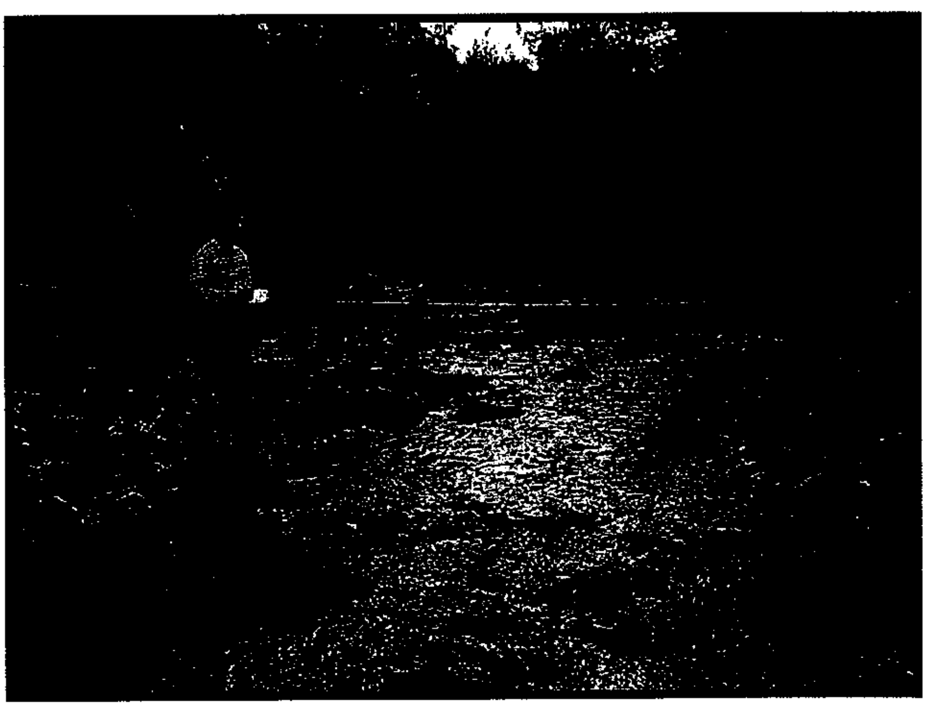


Photo S-14, looking upstream. Cross section 1 at Jack Creek survey reach. Note inset floodplains on channel margins - good bankfull indicators. Map Plate 1b Location: W-88

Mine Waste Rock and Tailings Locations

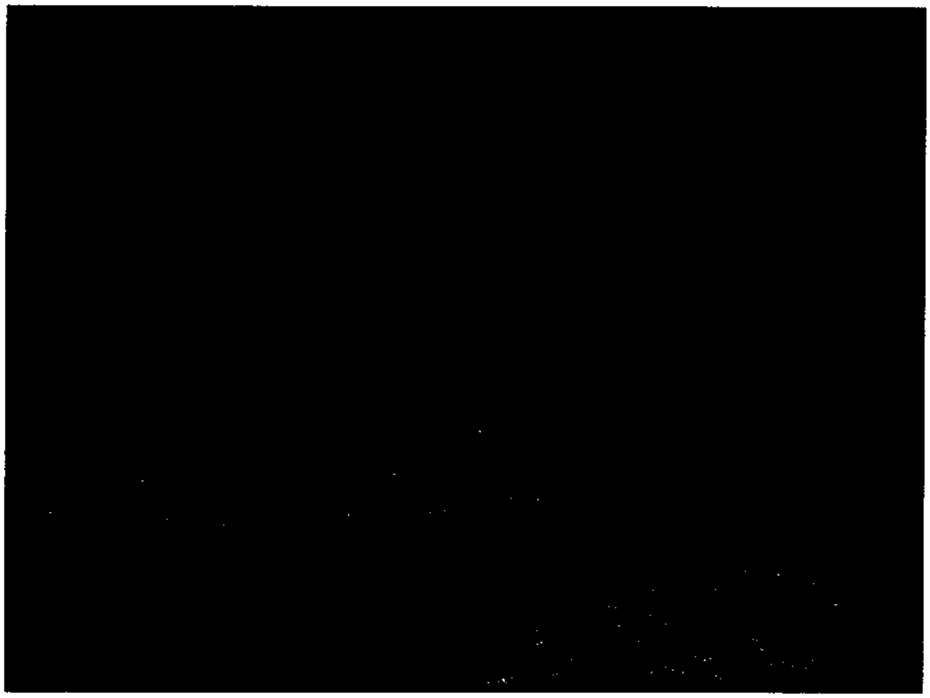


Photo T-1, right edge of water. Site located downstream of width measurement W-60. Tailings adjacent to channel for 55 feet. Map Plate 1a Location: W-60

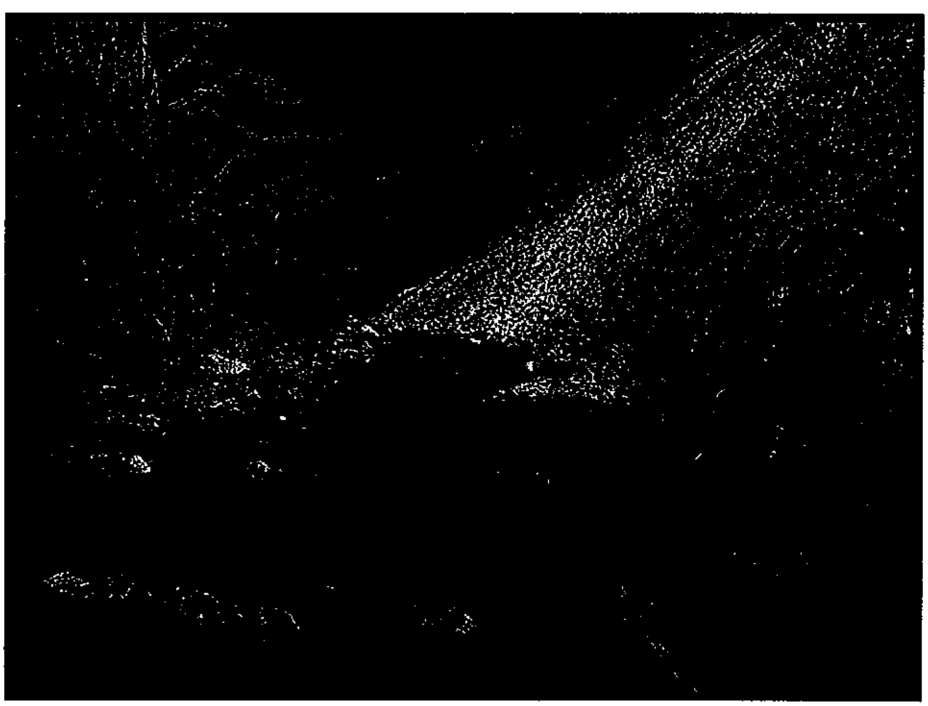


Photo T-2, looking downstream. Site located at width measurement site W-68. Tailings and waste rock adjacent to channel for 394 feet. Map Plate 1a Location: W-68

Photo T-3, looking downstream. Site located downstream of width measurement site W-68. Note rock staining downstream of Greylock shaft adit waters. Map Plate 1a Location: W-68

Photo T-4, looking upstream at Greylock shaft adit water flowing into West Fork Jarbidge River. Flow estimated at ± 0.5 cfs. Map Plate 1a Location: W-70

Photo T-5, looking downstream. Site located downstream of confluence with Bear Creek. Substrate has Fe/Mn slime coating bed elements. Map Plate 1a Location: W-69

Photo T-6, looking downstream. Site located upstream of bridge location Br- 10. Tailings isolated from active channel with 3 to 5 foot rip rap berm after 1995 flood. Tailings adjacent to rip rap for 453 feet. Map Plate 1a Location: W-70

Photo T-3, looking downstream. Site located downstream of width measurement site W-68. Note rock staining downstream of Greylock shaft adit waters. Map Plate 1a Location: W-68

Photo T-4, looking upstream at Greylock shaft adit water flowing into West Fork Jarbidge River. Flow estimated at $\pm$ 0.5 cfs. Map Plate 1a Location: W-70

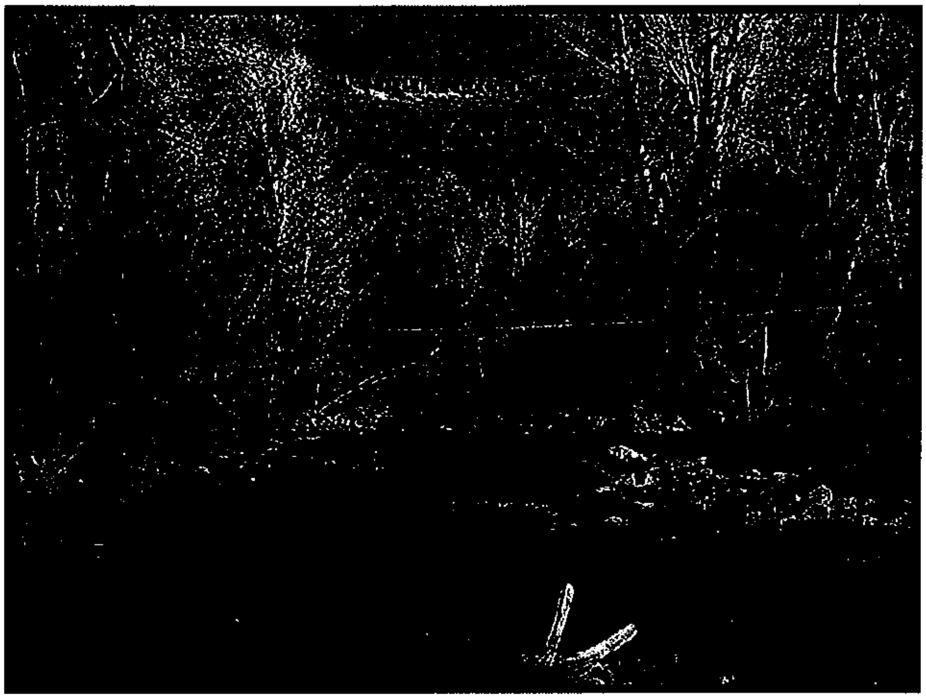


Photo EF-3, looking downstream. Cross section 1, Robinson Hole survey reach.

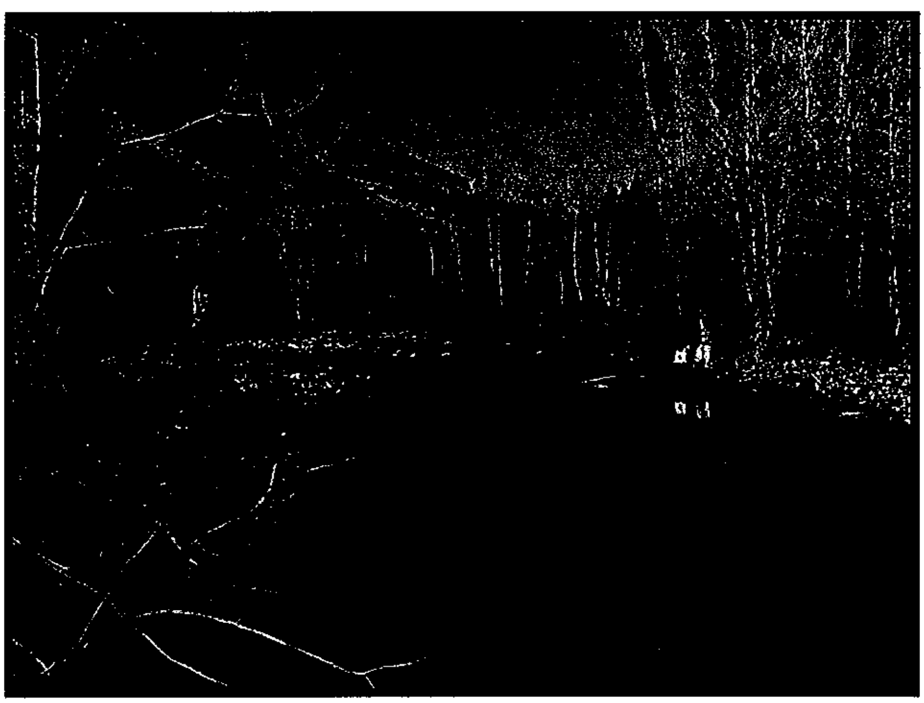


Photo EF-4, upstream of Robinson's Hole. Miscellaneous channel width measurements East Fork Jarbidge River.

Photo EF-5, upstream of Robinson's Hole. Miscellaneous channel width measurements East Fork Jarbidge River.

Photo EF-6, upstream of Robinson's Hole. Miscellaneous channel width measurements East Fork Jarbidge River.

Photo EF-7, upstream of Robinson's Hole. Miscellaneous channel width measurements East Fork Jarbidge River.

APPENDIX B

Road Maintenance Inventory Results

Appendix B: Road Maintenance Inventory Results

Key

Road segment numbering keys to road maintenance map plate

Berm type - RB = road berm adjacent to channel, RB - 25 = road berm located within 25 feet of channel
RB - 25 U/L = road berm in upper (U) or lower (L) part of road segment

distance = length of berm

Vegetation = qualitative field rating of vegetation, 0 - no vegetation, 5 - high understory and forb density and sediment filtration capacity

Active/Inactive = road berm which is freshly disturbed, road berm which is fully vegetated

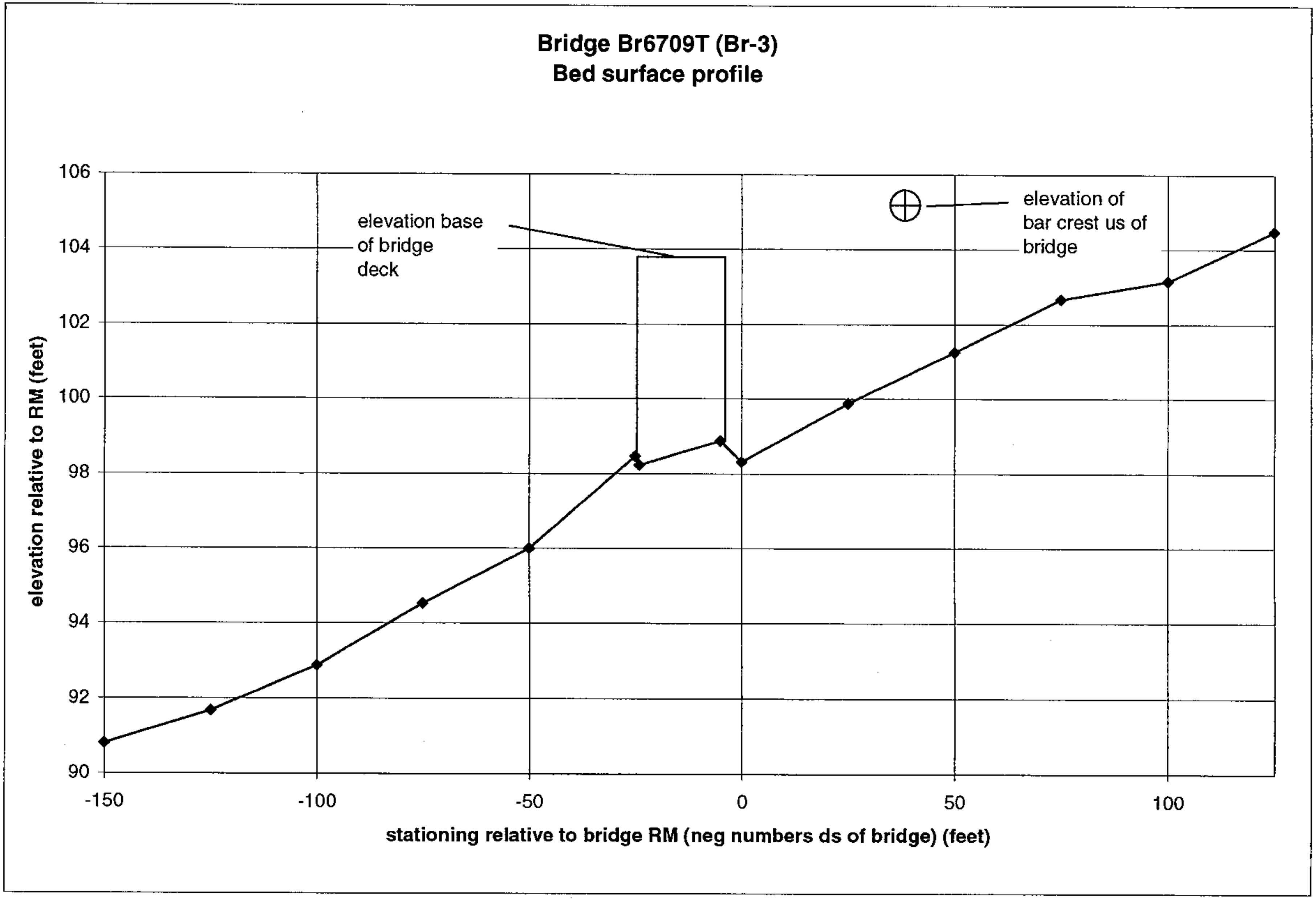
Road segment	Berm type	Distance feet	Vegetation	Active/Inactive	Notes
B-1	RB-25	138	4	Y	
B-2	RB-25U	45	4	Y	
B-2	RB	148	0	Y	rip rap on channel banks
B-2	RB-25L	24	4	Y	
B-3	RB-1	88	2	Y	toe of active debris fan
B-3	RB-2	180	0	Y	toe of active debris fan
B-3	RB-3	152	1	Y	toe of active debris fan
B-3	RB-25L	120	4	Y	toe of active debris fan
B-4	RB-25	178	5	Y	3 feet wide
B-5	bridge deck	30	0	y	Br 6495T
B-6	RB-25U	25	4	Y	sediment can reach flood plain channel
B-6	RB	40	2	Y	sediment can reach flood plain channel
B-6	RB-25L	24	4	Y	sediment can reach flood plain channel
B-7	RB-25U	15	3	Y	2' high x 5' wide, active source
B-7	RB	216	1	Y	2' high x 5' wide, active source
B-7	RB-25L	74	4	Y	2' high x 5' wide, active source
B-8	bridge deck	30	0	y	Br 6462T
B-9	RB-25U	131	4	Y	0.7' high x 2.5' wide
B-9	RB	49	0	Y	1' wide
B-9	RB-25L	218	3	Y	not direct source
B-10	RB	121	0	Y	1' high x 2.5' wide, active source
B-10	RB-25L	10	0	Y	1' high x 2.5' wide, active source
B-11	RB-25U	59	2	Y	0.5' high x 3' wide, rip rap sections
B-11	RB	114	0	Y	0.5' high x 3' wide, rip rap sections
B-11	RB-25L	52	4	Y	0.5' high x 3' wide, rip rap sections
B-12	bridge deck	30	0	Y	Br 6396T
B-13	RB-25U	90	2	Y	0.4' high x 1.5' wide, active source
B-13	RB	202	0	Y	1' high x 3' wide, active source
B-13	RB-25L	49	4	Y	active source
B-14	RB-25U	25	4	Y	1.5' high x 5.5' wide, active source
B-14	RB-1	226	0	Y	1' high x 1' wide, active source
B-14	RB-25M	385	4	Y	1' high x 1' wide, active source
B-14	RB-2	260	0	Y	1' high x 1' wide, active source
B-14	RB-25L	339	3	Y	1' high x 4' wide
B-15	RB-25	130	4	Y	
B-16	RB-25U	48	5	Y	0.8' high x 1.5' wide, active source
B-16	RB	48	0	Y	0.8' high x 1.5' wide, active source
B-16	RB-25L	26	5	Y	0.8' high x 1.5' wide, active source
B-17	RB-25U	94	3	N	vicinity of Br 6304T

Appendix B: Road Maintenance Inventory Results					
Key					
Road segment numbering keys to road maintenance map plate					
Berm type - RB = road berm adjacent to channel, RB - 25 = road berm located within 25 feet of channel RB - 25 U/L = road berm in upper (U) or lower (L) part of road segment					
distance = length of berm					
Vegetation = qualitative field rating of vegetation, 0 - no vegetation, 5 - high understory and forb density and sediment filtration capacity					
Active/Inactive = road berm which is freshly disturbed, road berm which is fully vegetated					
Road segment	Berm type	Distance feet	Vegetation	Active/Inactive	Notes
B-17	RB-1	15	0	Y	vicinity of Br 6304T
B-17	bridge deck	30	0	Y	Br 6304T
B-17	RB-2	21	0	Y	0.5' high x 1.5' wide
B-17	RB-25L	8	0	Y	0.5' high x 1.5' wide
B-18	RB-25U	77	3	Y	0.5' high x 1' wide, active source
B-18	RB	133	0	Y	rip rap on channel banks, active source
B-18	RB-25L	55	4	Y	0.5' high x 1' wide, active source
B-19	RB-25-1	145	4	Y	active source
B-19	RB-25-2	168	2	Y	1' high x 1.5' wide, active source
B-19	RB-1	139	0	Y	1' high x 2' wide, some rip rap
B-19	RB-25-3	133	3	Y	0.4' high x 1' wide
B-19	RB-25-4	210	4	Y	0.4' high x 1.5' wide, active source
B-19	bridge deck	30	0	Y	Br 6236T
					all of B-19 active source
B-20	bridge deck	30	0	Y	BR 6162T
B-21	RB-25U	185	3	N	
B-21	RB-1	181	0	Y	0.5'high x 1' wide, active source
B-21	RB-25M	174	1	Y	1' high x 2.5' wide, active source
B-21	RB-2	216	0	y	active source
B-22	RB-25	190	4	Y	1' high x 2' wide, will reach flood plain
B-23	RB-25	116	1	Y	1' high x 6' wide, will reach flood plain
B-24	RB-25U	28	2	Y	active source
B-24	RB	78	0	Y	1' high x 2' wide, some rip rap
B-24	RB-25L	65	2	Y	active source
B-25	RB-25U	44	3	Y	active source
B-25	RB	87	0	Y	1.5' high x 3.5' wide, active source
B-25	RB-25L	23	2	Y	active source
B-26	RB-25-1	19	1	Y	
B-26	RB-1	266	0	Y	dry ravel, slumping
B-26	RB-2	165	0	Y	
B-26	RB-25-2	150	3	Y	
B-26	RB-3 thru 7	1130	0	Y	0.5' high x 1' wide, dry ravel, slumping
B-26	RB-25-4	79	2	Y	
B-26	RB -8+9	347	0	Y	active source
B-26	RB-25-5	184	2	Y	rocky berm
B-27	RB-25U	51	0	Y	1' high x 2' wide
B-27	RB-1	132	0	Y	active source
B-27	RB-25L	22	1	Y	1'high x 2.5' wide, some rip rap

APPENDIX C

Bridge Inventory Results

Bridge Number	Br 6709T
Bridge Opening	17.8 feet wide, 5.25 feet high no intermediate piers
Upstream Conditions	
Channel	Channel flowing through sediments derived from Fox Creek Large cut slope on left edge in Fox Creek sediments Boulder through cobble substrate Elevated bar deposits upstream of bridge (profile) - indicate ponding during high flows
Floodplain	wide valley width but channel inset in Fox Creek sediments active channel has limited access to floodplain
Debris	No debris blockage observed
Bridge Section	Bridge located at cross over between set of meanders Bridge limiting channel migration potential in reach - forcing channel against Fox Creek sediments Bridge is constriction during high flows - upstream bar surface above elevation of bridge deck invert Contraction scour may occur during high flows Approach sections do not appear to be restricting flood flow - access to floodplain Local erosion on upstream wing walls Local scour on right abutment
Downstream Conditions	Do not observe bank erosion downstream Channel has very limited access to floodplain
Summary	Bridge may control channel alignment and planform adjustment Bed profile suggests local increase in slope through bridge section Contraction scour may be more evident during flood events Bridge is channel constriction - bridge opening less than- up and downstream bankfull widths upstream widths / bridge width / downstream widths 23.3' / 17.8' / 24.2' 27.4' / / 23.2'


Bridge Br6709T (Br-3)
Bed surface profile
elevation base of bridge deck
elevation of bar crest us of bridge
106
104
102
100
98
96
94
92
90
elevation relative to RM (feet)
-150
-100
-50
0
50
100
stationing relative to bridge RM (neg numbers ds of bridge) (feet)

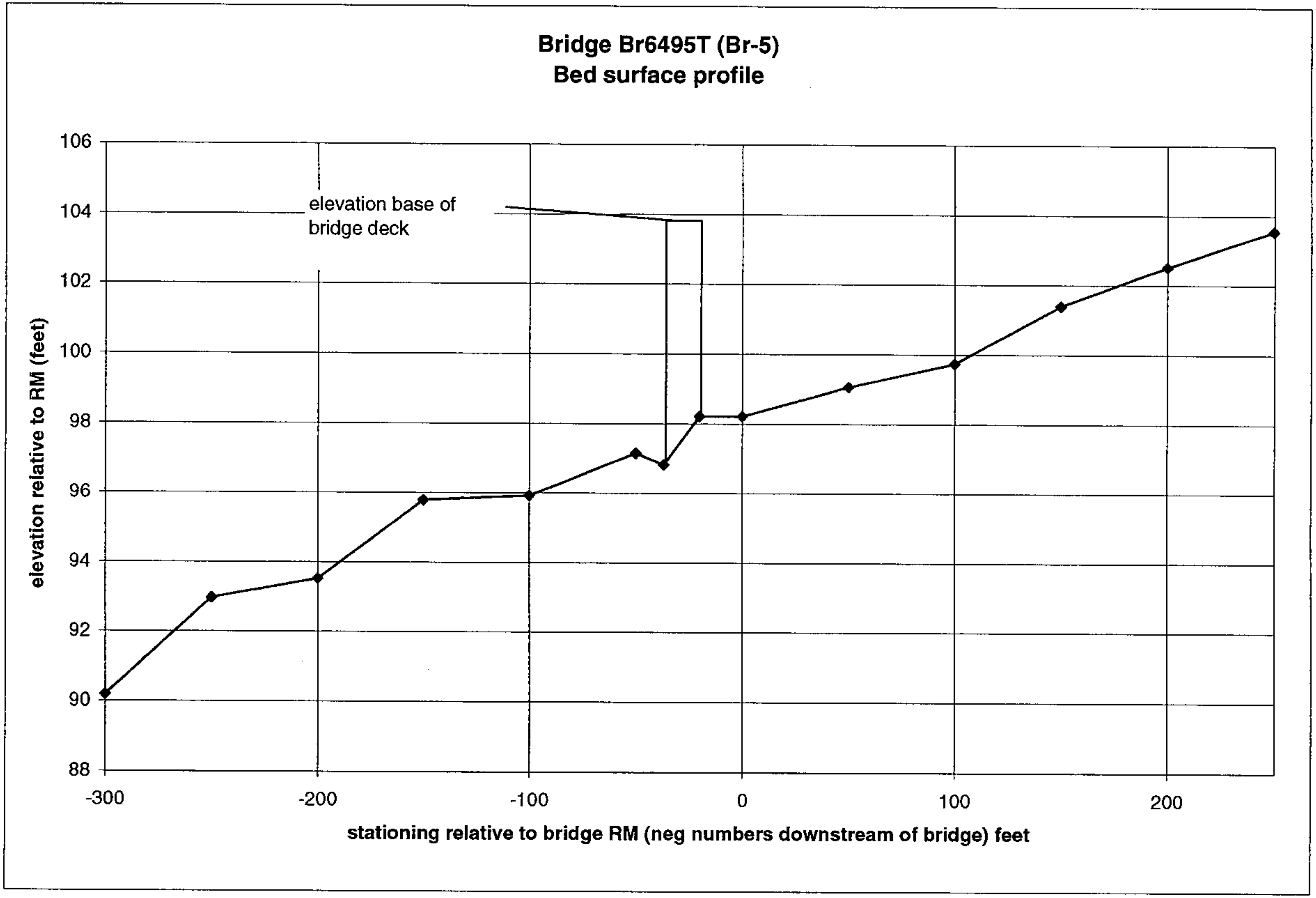
Bridge Number	Br 6658T
Bridge Opening	18 feet wide, 3.5 feet high No intermediate piers
Upstream Conditions	
Channel	Disturbed reach Channel captured by road during high flood event (1995) Channel avulsion occurred behind large wood debris jam - remnants still in channel, approximately 300 feet upstream of bridge Immediately upstream of bridge, active channel in road prism Coarse substrate - small boulder through cobble
Floodplain	Road in accessible floodplain, lead to channel capture Channel does have access to valley width in this reach
Debris	Woody debris upstream of bridge lead to abandonment of current bridge
Bridge Section	Bridge does not convey flow Channel located on left approach to bridge Bed profile not completed due to bridge condition Aggraded section through current bridge opening
Downstream Conditions	93 feet of road prism obliterated downstream of bridge section Channel still stabilizing from 1995 flood event Coarse substrate - small boulder through cobble
Summary	Bridge section abandoned during 1995 channel avulsion Bridge section may be fully or partially reactivated due to unstable - channel conditions in reach Bridge in functioning condition is channel constriction Limited flow area may have partly initiated bridge failure due to - debris blockage in approach section

upstream width	bridge width	downstream width
24.2'	18'	22.4'
		21'

Bridge Number	Br 6495T
Bridge Opening	26 feet wide, 5.9 feet high No intermediate piers
Upstream Conditions	
Channel	Coarse substrate - small boulder through cobbles Reach has wide valley width and well developed riparian vegetation channel forced to left valley margin by bridge location Channel migrating toward left abutment Historic dredging in approaches to bridge No evidence for ponding upstream of bridge - transport section Channel planform partly controlled by bridge opening - appears reach has reduced sinuosity due to bridge location
Floodplain	Road approach on right margin reducing accessible floodplain - approach road crosses entire valley width Currently, river does not access floodplain area
Debris	No debris blockage observed
Bridge Section	Local scour in bridge section (profile) Local scour at left abutments Gabion wing wall on left bridge abutment suggests longer term - concentration of stream power here
Downstream Conditions	Erosion on right channel margin inferred to be related to increases in - stream power downstream of bridge during flood events Reach downstream of bridge identified as unstable - high slope, large - depositional zones, and reduced sinuosity
Summary	Combination of Br 6495T and downstream Br 6462T may be controlling - channel planform leading to reduced sinuosity and channel instability Report recommendation - complete longer term surveying in reach - to examine channel processes and causes of instability Bridge may act as flow area constriction during flood flows - note eroding banks downstream of bridge section

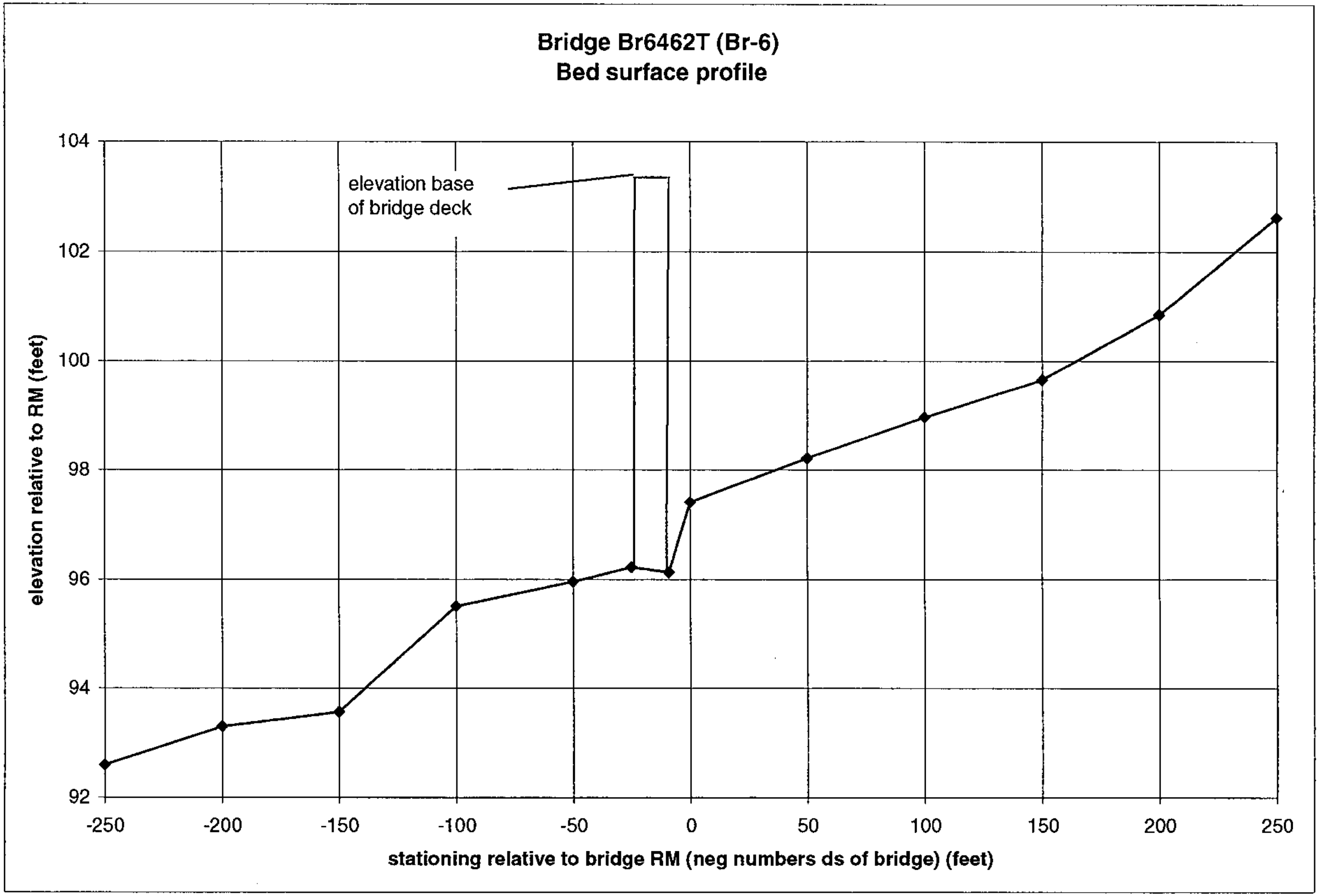
upstream widths	bridge width	downstream widths
89*	26	44**
32		29

* short braided reach
** channel overwide due to bank erosion and high sediment inputs in -
bridge exit section



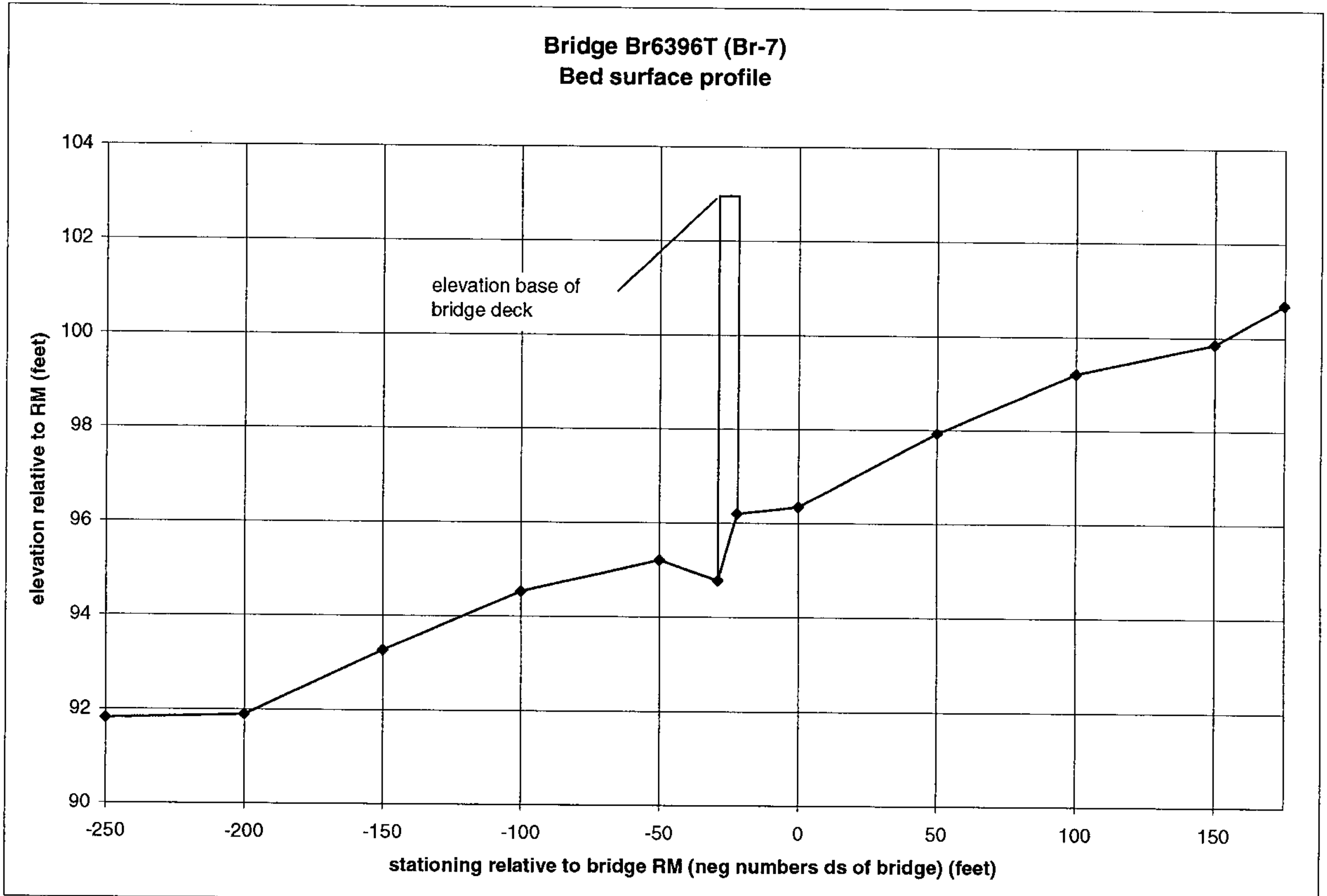
Bridge Br6495T (Br-5)
Bed surface profile
elevation base of bridge deck
106
104
102
100
98
96
94
92
90
88
-300
-200
-100
0
100
200
elevation relative to RM (feet)
stationing relative to bridge RM (neg numbers downstream of bridge) feet

Bridge Number	Br 6462T
Bridge Opening	29.7 feet wide, 8.6 feet high No intermediate piers
Upstream Conditions	
Channel	Uniform straight run upstream of bridge Cobble through gravel substrate Profile data and photos suggest small sediment lobe deposited - upstream of bridge opening Bridge section may influence channel planform patterns - but downstream Bonanza Gulch debris fan is primary planform control
Floodplain	Road approaches constrict flood flows to bridge opening Active channel has limited access to floodplain
Debris	No debris blockage observed
Bridge Section	Limited erosion on upstream wingwalls Local scour on right abutment Scour through bridge section Road approaches may restrict lateral expansion of flood flows Bridge has good conveyance characteristics
Downstream Conditions	
Channel	Historic dredging downstream of bridge - may have influence on bed profile Uniform run Cobble through gravel substrate Active channel does not have access to floodplain
Summary	Bridge located in downstream part of disturbed and adjusting reach and - upstream of river reach inset into Bonanza Gulch Fan Bridge is channel constriction and effective flow area and floodplain- constriction may increase stream power in exit section upstream widths / bridge width / downstream width 31' / 29.7' / 35' 30' / / 35'

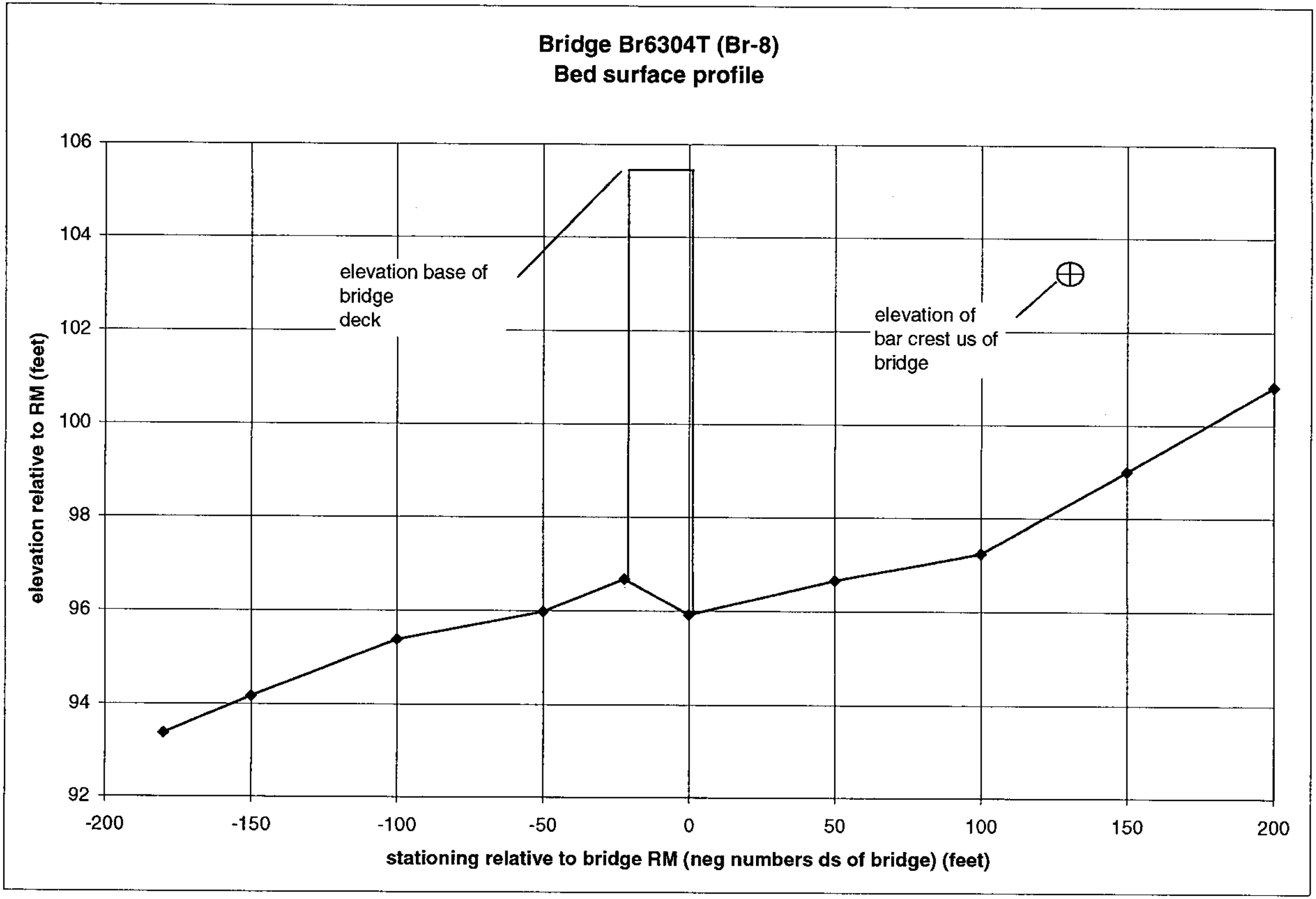


Bridge Br6462T (Br-6)
Bed surface profile
elevation base
of bridge deck
104
102
100
98
96
94
92
-250
-200
-150
-100
-50
0
50
100
150
200
250
elevation relative to RM (feet)
stationing relative to bridge RM (neg numbers ds of bridge) (feet)

Bridge Number	Br 6396T
Bridge Opening	28 feet wide, 6.9 feet high maximum height BS to base of bridge deck 9.4 feet No intermediate piers
Upstream Conditions	
Channel	Bridge located in cross over between meander bends Coarse substrate - boulder through gravel No active erosion upstream of bridge - left edge of channel - has bedrock on margin
Floodplain	Right side approach road cuts across accessible valley width - road will constrict flood flows which inundate floodplain Channel currently has limited access to floodplain
Debris	No debris blockage observed Bridge has poor alignment and potential for debris blockage exists
Bridge Section	Bridge has poor alignment - large contraction losses upstream due to channel bend Local scour on left abutment Deposition on right abutment Profile suggests contraction scour through bridge section Bridge does force channel to maintain current planform - but well developed meander exists up and downstream of bridge section
Downstream Conditions	Uniform run downstream of bridge Cobble through gravel substrate Bank erosion not observed - well developed riparian vegetation
Summary	Approach road constricts floodplain inundating flows Road has locally poor alignment upstream Contraction scour through bridge section Bridge not clearly flow area constriction, but bridge + right approach road are - high flow constriction upstream widths / bridge width / downstream width 25' / 28' / 28' 24'

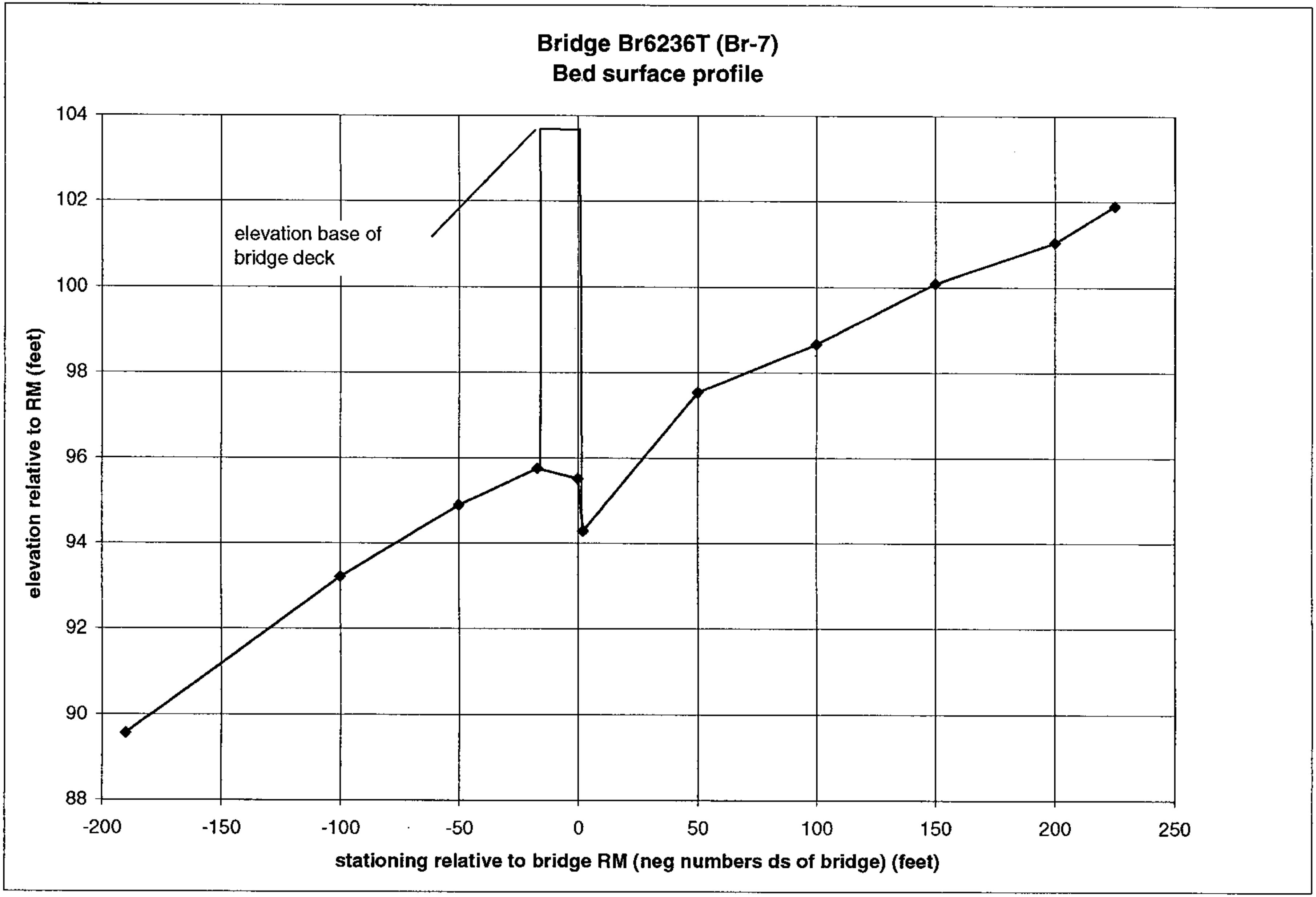

Bridge Br6396T (Br-7)
Bed surface profile
elevation base of
bridge deck
104
102
100
98
96
94
92
90
elevation relative to RM (feet)
-250
-200
-150
-100
-50
0
50
100
150
stationing relative to bridge RM (neg numbers ds of bridge) (feet)

Bridge Number	Br 6304T
Bridge Opening	bridge width 29 feet, bridge height 9.9 feet bridge width perpendicular to flow 26 feet No intermediate piers
Upstream Conditions	
Channel	Bridge located in cross over between restricted meanders Bridge located in reach with reduced valley width and - segments of road encroachment on active channel Cobble through gravel substrate Large depositional bar upstream on right channel margin Bridge has poor alignment - combination of alignment, flow area constriction, and upstream sediment sources cause deposition On left margin 220' by 4' high cut slope in terrace slope - cut slope appears related to deposition and migration to left channel margin
Floodplain	Left road approach restricting flood flow access to floodplain Active channel has limited access to floodplain
Debris	No debris blockage observed Potential for debris accumulation exists due to poor upstream alignment
Bridge Section	Scour not observed on abutments Potentially large contraction losses due to poor approach alignment Overall depositional reach at bridge
Downstream Conditions	Uniform run downstream of bridge Small boulder to cobble substrate 80 feet of actively eroding bank on right edge - appears related to increased stream power downstream of bridge section Channel area may have been historically dredged
Summary	Bridge not clearly identified as width constriction Bridge + approach road appear to be constriction during floodplain - inundating flows upstream widths / bridge width / downstream widths 23' / 29' / 29' 30' / / 39'


Bridge Br6304T (Br-8)
Bed surface profile
106
104
102
100
98
96
94
92
elevation relative to RM (feet)
-200
-150
-100
-50
0
50
100
150
200
stationing relative to bridge RM (neg numbers ds of bridge) (feet)
elevation base of bridge deck
elevation of bar crest us of bridge

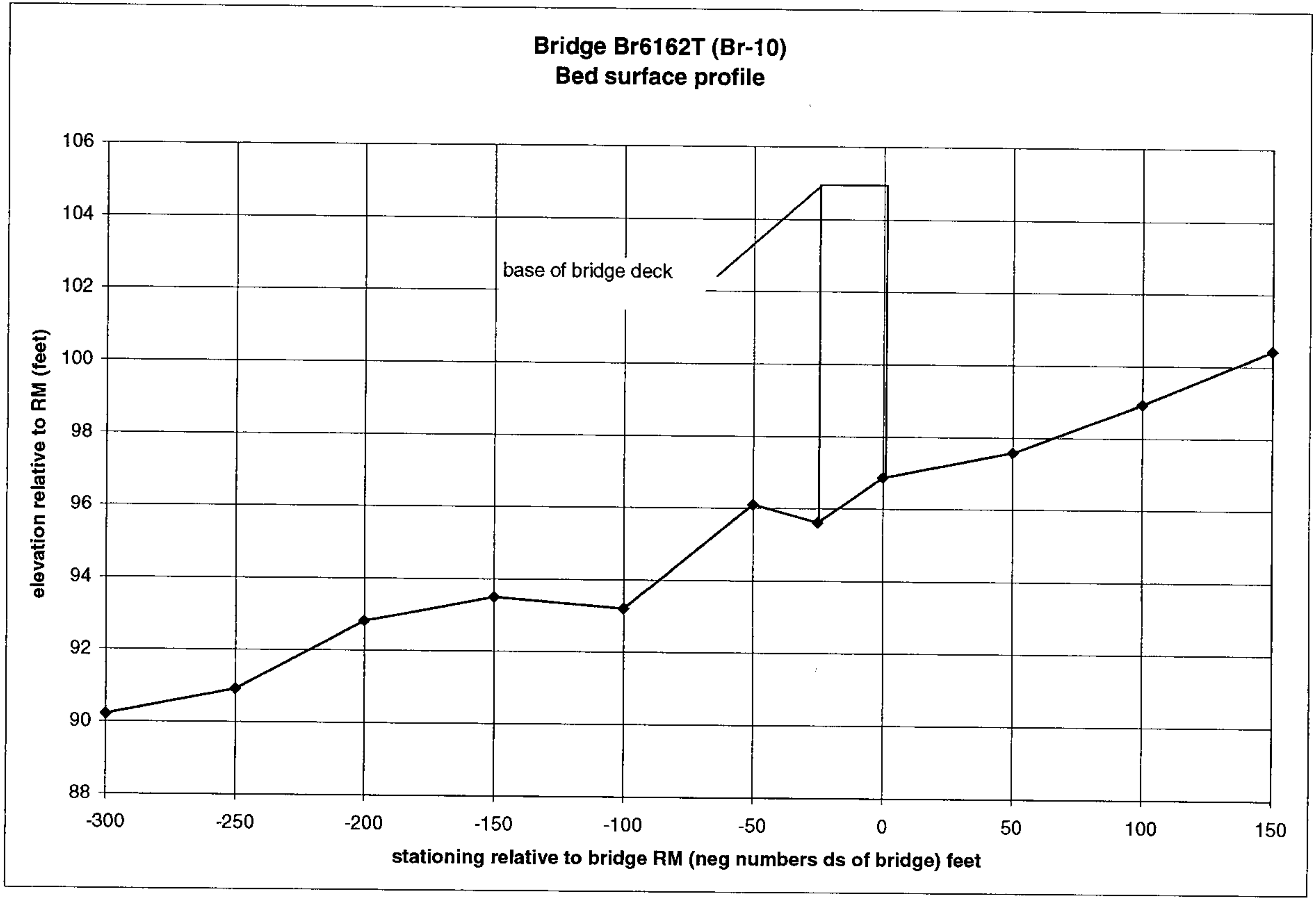
Bridge Number	Br 6236T
Bridge Opening	bridge 9.6 feet high, width estimate 28 feet No intermediate piers
Upstream Conditions	
Channel	Channel flowing through toe of debris fan area Historic disturbance footprint from mining and townsite development Channel confined within debris fan sediments Bridge located on downstream axis of meander bend which is migrating to left valley edge Small boulder through cobble substrate Profile indicated bed degradation for 50 feet upstream of bridge
Floodplain	Channel has limited access to floodplain - flowing through toe of fan
Debris	No debris blockage observed Potential for debris blockage exists due to poor bridge alignment
Bridge Section	Abutment scour not observed Profile indicates there may be contraction scour through bridge section Bridge has poor upstream alignment - may lead to large contraction losses Left wingwall failing - miscellaneous fill placed there
Downstream Conditions	Cobble through gravel substrate Large continuous cutslope downstream of bridge Cutslope over 13 feet in height Appears erosion due to combination of processes - Debris fan inputs, historic mining and townsite impact, and increased stream power - downstream of bridge section
Summary	Bridge has poor alignment Contraction scour probable Bridge wingwalls failing Combination of bridge opening and alignment appear to reduce channel flow area upstream widths: 23', 33' — bridge width: ~28' — downstream width: 25'

upstream widths	bridge width	downstream width
23'	~28'	25'
33'		


Bridge Br6236T (Br-7)
Bed surface profile
elevation base of bridge deck
elevation relative to RM (feet)
104
102
100
98
96
94
92
90
88
-200
-150
-100
-50
0
50
100
150
200
250
stationing relative to bridge RM (neg numbers ds of bridge) (feet)

Bridge Number	Br 6162T
Bridge Opening	Bridge width 28.8 feet, bridge height 7.8 feet No intermediate piers
Upstream Conditions	
Channel	Highly disturbed reach - historic wasterock and mill tailings in floodplain, recent dredging Straight reach through bridge section Cobble substrate Limited riparian vegetation
Floodplain	Wide potentially accessible valley width, but historic activity has eliminated channel access to floodplain
Debris	No debris blockage observed
Bridge Section	Local scour on right abutment Bridge has good alignment and conveyance characteristics No ponding observed on upstream end
Downstream Conditions	Highly disturbed reach - historic wasterock and mill tailings in floodplain, recent dredging Gabion walls on right edge of water Cobble substrate
Summary	Potential influence of bridge masked by other disturbances

upstream widths	bridge width	downstream widths
28'	28.8'	29'
64'*		25'

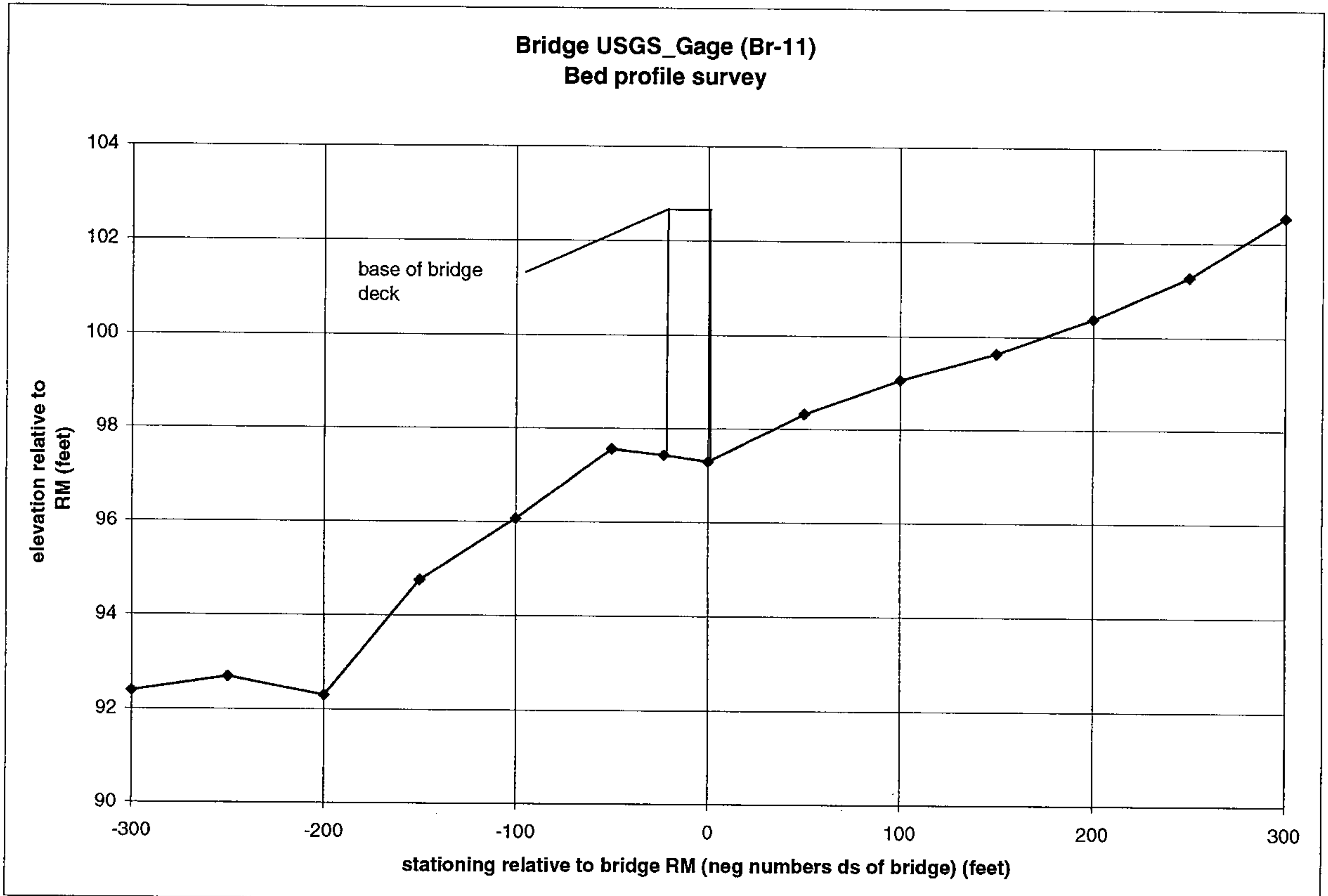


Bridge Br6162T (Br-10)
Bed surface profile
base of bridge deck
elevation relative to RM (feet)
106
104
102
100
98
96
94
92
90
88
-300
-250
-200
-150
-100
-50
0
50
100
150
stationing relative to bridge RM (neg numbers ds of bridge) feet

Bridge Number	Br USGS-Gage - vicinity of Mahoney Guard Station
Bridge Opening	Bridge height 5.5 feet, bridge width 39 feet No intermediate piers
Upstream conditions	
Channel	Overall depositional and locally braided reach Straight channel through bridge reach Channel has been recently dredged up and downstream of bridge Cobble substrate Do no observe sediment deposition or ponding upstream of bridge
Floodplain	In large flood flows, floodplain will be inundated Low and intermediate flood flows, right approach road and dredging will - reduce overbank flows
Debris	No debris blockage observed
Bridge Section	Depositional reach - do not observe scour at abutments Bridge has good conveyance characteristics Bridge controls local channel planform
Downstream Conditions	Depositional reach - do not observe bank erosion Increase in slope downstream of bridge (profile) may be related to - bridge control on channel planform, decrease in sinuosity, and increase in slope Cobble substrate
Summary	Depositional reach Bridge is locally controlling channel alignment

upstream widths	bridge width	downstream widths
72'*	39'	25'
32'		24'

* braided section


Bridge USGS_Gage (Br-11)
Bed profile survey
104
102
100
98
96
94
92
90
elevation relative to RM (feet)
base of bridge deck
-300
-200
-100
0
100
200
300
stationing relative to bridge RM (neg numbers ds of bridge) (feet)

APPENDIX D

Road–Channel Interaction Reaches

Appendix D: Road - Channel Interaction Reaches

Key

Reach - references reach number on Road - Channel Interactions Map Plate
Channel length - length of river channel, measured in the field
Widths - Channel width measurements
Photos - photo log
Notes - general observations related to road sediment sources, road encroachment, and incision

Reach	Channel Length feet	Widths	Photos	Notes
R-1	1366	W-14 W-15	1-18 1-19	Road prism captured in 1995 flood and partly obliterated by debris from Snowslide gulch Former road prism in accessible valley floor Hybrid sediment source - debris from Snowslide Gulch + former road prism Incision not observed - current active channel 1.7 feet below pre-1995 channel bed at W-15 Debris from 1995 event in Snowslide Gulch ends 1,308 feet down reach
R-2	670	W-16		Channel incised in toe of small debris fan Road not in accessible valley width Channel not interacting with road prism, road not identified as sediment source
R-3	124	W-17	R-1	Channel migrating into road prism Road prism is direct bank sediment source Road in accessible valley floor Incision not observed
R-4	1525	W-18	1-20	Road located on valley margin in potentially accessible valley floor Channel not interacting with road prism, road not identified as sediment source Incision not observed Do not observe scoured channel or deposition on terrace surfaces which may be associated with 1995 event
R-5	99	W-19		Channel migrating into road prism Road prism is direct bank sediment source Road in accessible valley floor Incision not observed
R-6	153			No road-related sediment sources No incision observed Road is located in accessible valley width

Appendix D: Road - Channel Interaction Reaches

Key

Reach - references reach number on Road - Channel Interactions Map Plate

Channel length - length of river channel, measured in the field

Widths - Channel width measurements

Photos - photo log

Notes - general observations related to road sediment sources, road encroachment, and incision

Reach	Channel Length feet	Widths	Photos	Notes
R-7	251	W-20		No road-related sediment sources No incision observed Road is restricting accessible valley width
R-8	521	W-21		Depositional reach, incision not observed Road is outside accessible valley width Channel not interacting with road prism, road not identified as sediment source
R-9	201			Road located on toe of Gorge Gulch debris fan Road not located in accessible valley width Channel confined within debris fan sediments Road acting as a contributing maintenance-related sediment source along with debris sediments
R-10	210			Debris fan from Gorge Gulch has forced channel to left valley margin Road not in accessible valley width Road not identified as sediment source
R-11	596	W-23 W-24		No road-related sediment sources In lower part of section, road incised in sediments derived from Fox Creek Road located on valley margin in potentially accessible valley floor Incision not observed
R-12	928	W-25		Road not identified as sediment source Road located in accessible valley width Incision not observed, channel locally flowing over bedrock
R-13	163	W-26	B-9 B-10	Road overtopped by 1995 flood and obliterated Hybrid sediment source - road prism + flood debris Road located in accessible valley width Incision not observed, depositional reach

Appendix D: Road - Channel Interaction Reaches

Key

Reach - references reach number on Road - Channel Interactions Map Plate
Channel length - length of river channel, measured in the field
Widths - Channel width measurements
Photos - photo log
Notes - general observations related to road sediment sources, road encroachment, and incision

Reach	Channel Length feet	Widths	Photos	Notes
R-14	734	W-27 W-28	2-2 2-3	Generally in reach, road not active sediment source Upper 93 feet, road obliterated 15 feet of reach, road direct sediment source Road located on valley margin in potentially accessible valley floor Incision not observed, locally channel flows over bedrock
R-15	642	W-29	2-4	Restored channel reach Road not identified as active sediment source Road located in accessible valley width Incision not observed
R-16	299	W-30	2-5	Restored channel reach Road not identified as active sediment source Road located on valley margin in potentially accessible valley floor Incision not observed
R-17	555	W-32	2-8	Road not identified as active sediment source Road - Channel interactions not observed Road located on valley margin in potentially accessible valley floor Low level sediment contribution from Pine Creek Campground Incision not observed
R-18	212	W-33	2-9	Channel migrating into Pine Creek Campground Road Campground road active sediment source Main road located on valley margin in potentially accessible valley floor Incision not observed
R-19	316	W-34	2-10	Main road and campground road not identified as active sediment source Road and Pine Creek Campground in potentially accessible valley width Incision not observed

Appendix D: Road - Channel Interaction Reaches

Key

- Reach - references reach number on Road - Channel Interactions Map Plate
- Channel length - length of river channel, measured in the field
- Widths - Channel width measurements
- Photos - photo log
- Notes - general observations related to road sediment sources, road encroachment, and incision

Reach	Channel Length feet	Widths	Photos	Notes
R-20	177	W-35	R-4	Channel migrating into road prism Road armored with rip rap, but road fill is direct sediment source Road located in accessible valley width Incision not observed
R-21	222			Road not identified as active sediment source Road - Channel interactions not observed Road located on valley margin in potentially accessible valley floor Incision not observed
R-22	487	W-37	2-11	Road located on toe of debris fan Road is direct bank sediment source along with debris fan sediments Road is not in accessible valley width Incision not observed
R-23	788	W-39 W-40	2-13	Reach appears to have historic floodplain disturbance associated with mining Road not identified as active sediment source Road located in accessible valley width - reduces accessible width ~ 30% Free meanders in reach, incision not observed
R-24	358	W-41		Channel is migrating into road prism, but there is some riparian buffer Road in accessible valley width and restricting meanders Currently road minor active sediment source in reach Incision not observed
R-25	544	W-42	2-14	Reach appears to have historic floodplain disturbance associated with mining Road not identified as active sediment source Road located in accessible valley width Low level sediment contribution from campground
R-26	430			Bridge is forcing straightened channel alignment

Appendix D: Road - Channel Interaction Reaches

Key

Reach - references reach number on Road - Channel Interactions Map Plate
Channel length - length of river channel, measured in the field
Widths - Channel width measurements
Photos - photo log
Notes - general observations related to road sediment sources, road encroachment, and incision

Reach	Channel Length feet	Widths	Photos	Notes
R-27	1105	W-45 W-46	2-16 2-22	Disturbed reach - potentially related to road and bridge alignment Road not identified as active sediment source Road located in accessible valley width Reach is adjusting - depositional zones also chute cutoff on floodplain Recommend longer-term bench marked surveying
R-28	651	W-47	2-18	Continuation of R-27, but road is a direct bank sediment source Bridge in reach restricts channel migration Road direct sediment source upper 182 feet of reach Road located in accessible valley width and encroaching on active channel Recommend longer-term bench marked surveying
R-29	1096	W-48 W-50	2-20 2-21	Channel incised in Bonanza Gulch Fan Road not identified as active sediment source Road not in accessible valley width Bonanza Gulch survey reach
R-30	1478	W-52 W-53 W-54	R-6 B-42	At bridge location, road direct sediment source for 200 feet Road not direct sediment source in other parts of reach Road is located in middle of accessible valley width and is encroaching on meander pattern Reach is steep and appears incised. Potentially, decrease in sinuosity has increased slope leading to incision Recommend longer-term bench marked surveying
R-31	350			Road continuous sediment source Road located in accessible valley width
R-32	552	W-56	2-22	Road not identified as active sediment source Road located on valley margin in potentially accessible valley floor

Appendix D: Road - Channel Interaction Reaches

Key

Reach - references reach number on Road - Channel Interactions Map Plate
Channel length - length of river channel, measured in the field
Widths - Channel width measurements
Photos - photo log
Notes - general observations related to road sediment sources, road encroachment, and incision

Reach	Channel Length feet	Widths	Photos	Notes
R-33	1250	W-57 W-58	2-23	Road is acting as continuous sediment source in reach Narrow valley width Road located on valley margin in potentially accessible valley floor
R-34	1354	W-60	2-24	400 feet of road in reach is direct sediment source Reach partially braided (upstream sediment source?) Road located on valley margin in potentially accessible valley floor Incision not observed
R-35	3355	W-61 W-62 W-63 W-64	3-1 3-2 3-3	Road is active sediment source for 300 feet at Bourne Gulch In other segments road is not direct sediment source Narrow valley width Road located on valley margin in potentially accessible valley floor Incision not observed Limited road-channel interaction through reach
R-36	2840	W-67- 71	3-8 - 10 T-2-6	Reach located in Jarbidge Townsite, river forced to right valley margin No-road channel interactions
R-37	823	W-73	3-12	Reach starts at USFS boundary Road located on toe of Moore Gulch Debris fan Road direct sediment source for 200 feet of reach Road located on valley margin in potentially accessible valley floor Incision not observed
R-38	8445	W-74 - 82	3-13 - 20	Road not direct sediment source in reach Road located on valley margin in potentially accessible valley floor or outside of accessible valley floor Depositional reach, incision not observed

Appendix D: Road - Channel Interaction Reaches

Key

Reach - references reach number on Road - Channel Interactions Map Plate
Channel length - length of river channel, measured in the field
Widths - Channel width measurements
Photos - photo log
Notes - general observations related to road sediment sources, road encroachment, and incision

Reach	Channel Length feet	Widths	Photos	Notes
R-39	2960	W-83 - 88	3-21-24	Restricted valley width Road not located in accessible valley width Incision not observed Road is road maintenance-related sediment source Road not identified as bank sediment source

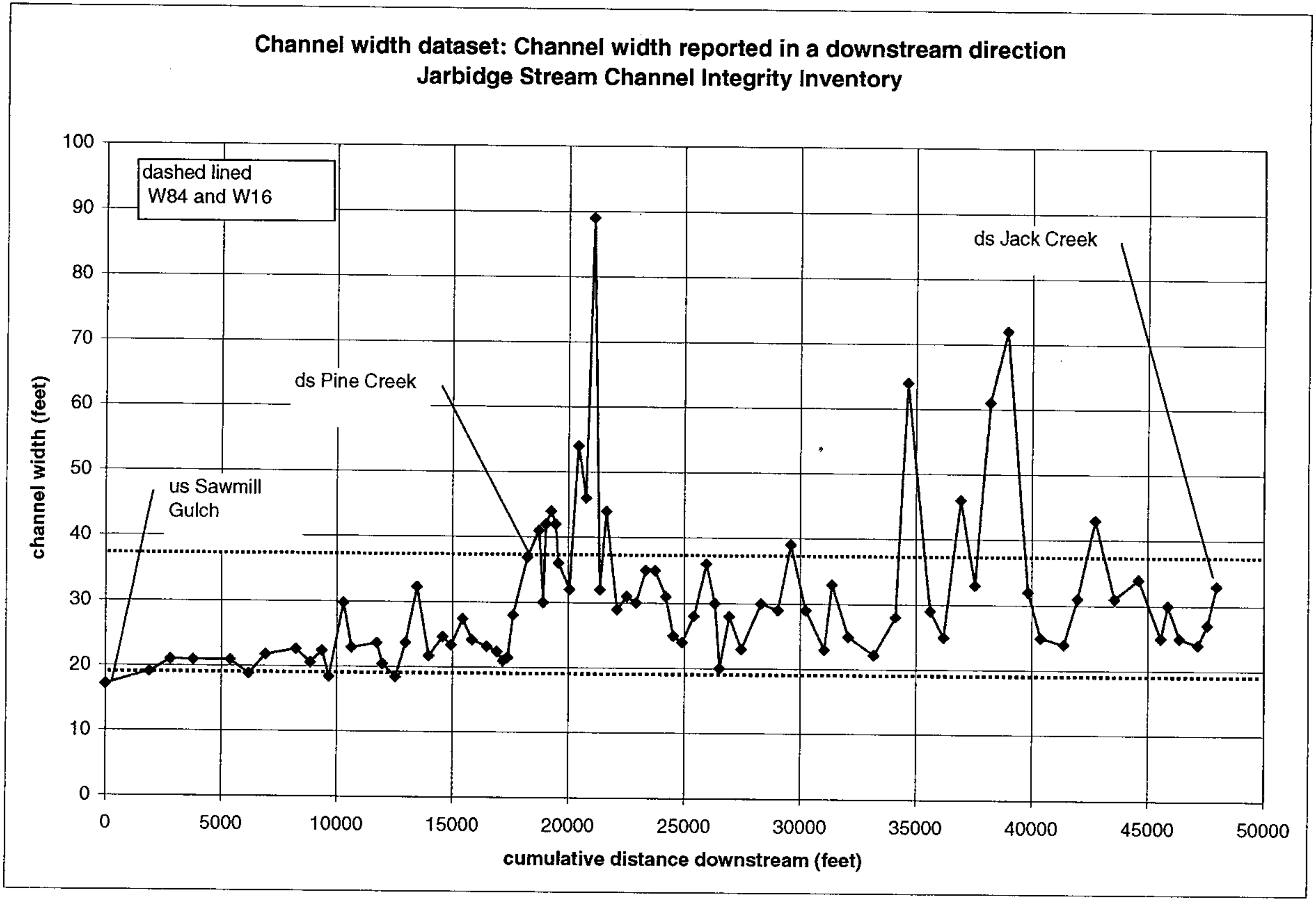
APPENDIX E

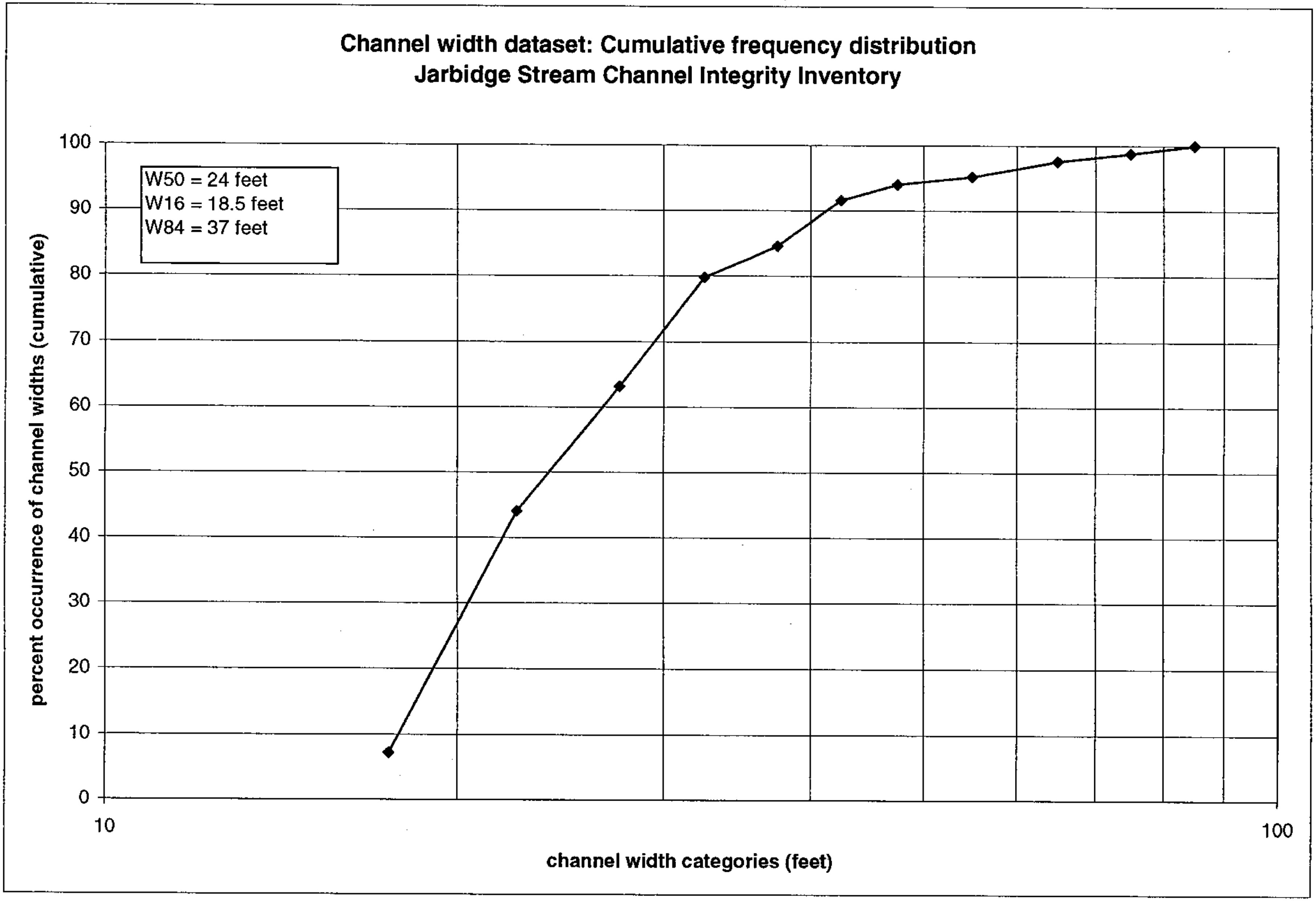
Channel Width Measurement Results

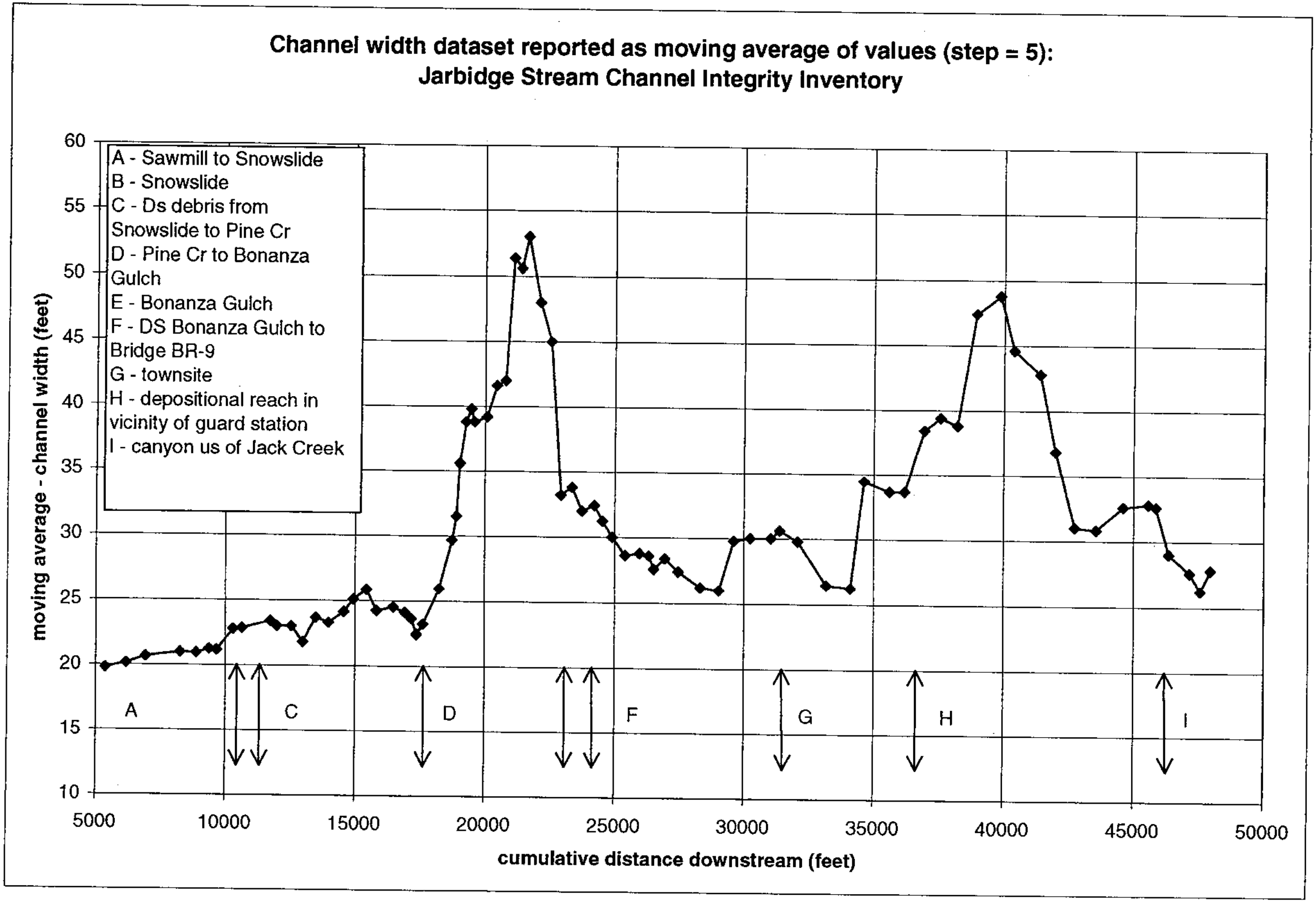
Appendix E: Channel Width Measurement Results, West Fork Jarbidge River and selected tributaries			
Map Symbol*	Channel Width	Cumulative	Notes
	feet	distance (ft)	
W-1	17.1	0	bankfull, upstream of Sawmill Gulch
W-2	19.1	1900	bankfull, stable, well vegetated debris fan
W-3	21	2800	bankfull, upstream of beaver ponds
W-4	20.9	3780	bankfull, upstream of historic crossing
W-5	20.9	5380	bankfull, entrenched channel
W-6	18.8	6180	active channel width = 18.8 ft, scoured channel width = 38.3 ft
W-7	21.8	6920	bankfull, short self-adjusting reach
W-8	22.6	8240	bankfull
W-9	20.6	8860	scoured channel, upstream of steep reach
W-10	22.4	9360	scoured channel, upstream of steep reach
W-11	18.4	9660	scoured channel
W-12	43		Snowslide Gulch
W-13	29.8	10300	scoured channel, downstream of Snowslide Gulch
W-14	22.9	10640	reach where river captured by road
W-15	23.6	11740	only one of two channel branches
W-16	20.4	11980	bankfull
W-17	18.4	12540	bankfull
W-18	23.7	12980	bankfull
W-19	32.3	13480	overwide channel adjacent to road
W-20	21.7	13980	
W-21	24.6	14580	
W-22	58		Gorge Gulch
W-23	23.3	14940	upstream of Fox Creek
W-24	27.4	15440	
W-25	24.2	15840	
W-26	23.2	16480	
W-27	22.4	16920	
W-28	21	17180	upstream of restored reach
W-29	21.5	17380	in restored reach
W-30	28	17620	in restored reach
W-31	21		Pine Creek
W-32	36.9	18240	downstream of Pine Creek
W-33	41	18740	
W-34	30	18910	bankfull
W-35	42	19040	road direct sediment source
W-36	44	19260	
W-37	42	19460	debris fan section
W-38	36	19580	
W-39	32	20060	bankfull
W-40	54	20440	
W-41	46	20780	
W-42	89	21100	depositional reach
W-43	32	21380	
W-44	44	21660	downstream of bridge
W-45	29	22120	active bar width 112 ft
W-46	31	22540	active bar width 112 ft
W-47	30	22940	

Appendix E: Channel Width Measurement Results, West Fork Jarbidge River and selected tributaries			
Map Symbol*	Channel Width	Cumulative	Notes
	feet	distance (ft)	
W-48	35	23360	
W-49	28		Bonanza Gulch
W-50	35	23760	
W-51	31	24220	
W-52	25	24540	
W-53	24	24920	
W-54	28	25420	
W-55	36	25960	
W-56	30	26320	bankfull
W-57	20	26520	encroached channel
W-58	28	26940	
W-59	23	27460	
W-60	30	28320	active bar width 83 ft
W-61	29	29040	
W-62	39	29600	
W-63	29	30240	
W-64	23	31040	
W-65	31		Bourne Gulch
W-66	33	31380	
W-67	25	32080	
W-68	22.2	33180	
W-69	28	34120	
W-70	64	34640	braided section
W-71	29	35620	
W-72	25	36200	
W-73	46	36950	
W-74	33	37570	
W-75	61	38210	braided section
W-76	72	38950	braided section
W-77	32	39850	
W-78	25	40390	
W-79	24	41390	
W-80	31	41990	
W-81	43	42750	
W-82	31	43570	
W-83	34	44610	
W-84	25	45570	
W-85	30	45870	
W-86	25	46370	
W-87	24	47170	
W-88	27	47570	
W-89	33	47970	

* locations key to map symbols in channel width map plate


Channel width dataset: Channel width reported in a downstream direction
Jarbidge Stream Channel Integrity Inventory
dashed lined
W84 and W16
ds Jack Creek
ds Pine Creek
us Sawmill
Gulch
channel width (feet)
100
90
80
70
60
50
40
30
20
10
0
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
50000
cumulative distance downstream (feet)


Channel width dataset: Cumulative frequency distribution
Jarbidge Stream Channel Integrity Inventory
W50 = 24 feet
W16 = 18.5 feet
W84 = 37 feet
percent occurrence of channel widths (cumulative)
0
10
20
30
40
50
60
70
80
90
100
10
100
channel width categories (feet)



Channel width dataset reported as moving average of values (step = 5):
Jarbidge Stream Channel Integrity Inventory
A - Sawmill to Snowslide
B - Snowslide
C - Ds debris from Snowslide to Pine Cr
D - Pine Cr to Bonanza Gulch
E - Bonanza Gulch
F - DS Bonanza Gulch to Bridge BR-9
G - townsite
H - depositional reach in vicinity of guard station
I - canyon us of Jack Creek
moving average - channel width (feet)
cumulative distance downstream (feet)
60
55
50
45
40
35
30
25
20
15
10
5000
10000
15000
20000
25000
30000
35000
40000
45000
50000
A
C
D
F
G
H
I

Appendix E: Channel Width Measurement Results, West Fork Jarbidge River and selected tributaries

Map Symbol*	cum dist	Channel Width feet	Notes
W-1	0	17.1	bankfull, upstream of Sawmill Gulch
W-2	1900	19.1	bankfull, stable, well vegetated debris fan
W-3	2800	21	bankfull, upstream of beaver ponds
W-4	3780	20.9	bankfull, upstream of historic crossing
W-5	5380	20.9	bankfull, entrenched channel
W-6	6180	18.8	active channel width = 18.8 ft, scoured channel width = 38.3 ft
W-7	6920	21.8	bankfull, short self-adjusting reach
W-8	8240	22.6	bankfull
W-9	8860	20.6	scoured channel, upstream of steep reach
W-10	9360	22.4	scoured channel, upstream of steep reach
W-11	9660	18.4	scoured channel
W-13	10300	29.8	scoured channel, downstream of Snowslide Gulch
W-14	10640	22.9	reach where river captured by road
W-15	11740	23.6	only one of two channel branches
W-16	11980	20.4	bankfull
W-17	12540	18.4	bankfull
W-18	12980	23.7	bankfull
W-19	13480	32.3	overwide channel adjacent to road
W-20	13980	21.7	
W-21	14580	24.6	
W-23	14940	23.3	upstream of Fox Creek
W-24	15440	27.4	
W-25	15840	24.2	
W-26	16480	23.2	
W-27	16920	22.4	
W-28	17180	21	upstream of restored reach
W-29	17380	21.5	in restored reach
W-30	17620	28	in restored reach
W-32	18240	36.9	downstream of Pine Creek
W-33	18740	41	
W-34	18910	30	bankfull
W-35	19040	42	road direct sediment source
W-36	19260	44	
W-37	19460	42	debris fan section
W-38	19580	36	
W-39	20060	32	bankfull
W-40	20440	54	
W-41	20780	46	
W-42	21100	89	depositional reach
W-43	21380	32	
W-44	21660	44	downstream of bridge
W-45	22120	29	active bar width 112 ft
W-46	22540	31	active bar width 112 ft
W-47	22940	30	
W-48	23360	35	
W-50	23760	35	
W-51	24220	31	

Map Symbol*	cum dist	Channel Width feet	Notes
W-52	24540	25	
W-53	24920	24	
W-54	25420	28	
W-55	25960	36	
W-56	26320	30	bankfull
W-57	26520	20	encroached channel
W-58	26940	28	
W-59	27460	23	
W-60	28320	30	active bar width 83 ft
W-61	29040	29	
W-62	29600	39	
W-63	30240	29	
W-64	31040	23	
W-66	31380	33	
W-67	32080	25	
W-68	33180	22.2	
W-69	34120	28	
W-70	34640	64	braided section
W-71	35620	29	
W-72	36200	25	
W-73	36950	46	
W-74	37570	33	
W-75	38210	61	braided section
W-76	38950	72	braided section
W-77	39850	32	
W-78	40390	25	
W-79	41390	24	
W-80	41990	31	
W-81	42750	43	
W-82	43570	31	
W-83	44610	34	
W-84	45570	25	
W-85	45870	30	
W-86	46370	25	
W-87	47170	24	
W-88	47570	27	
W-89	47970	33	

* locations key to map symbols in channel width map plate

APPENDIX F

Reach Summary

Reach/Length	West Fork Jarbidge ds Pine Creek	350 feet
Survey Date	6-Nov-01	
Stream Order/ Reach Elevation	3 rd order	6600 feet

Geomorphic Setting Alluvial valley with accessible width ~ 100 to 200 feet.
Restricted meander pattern - meanders migrate to valley margin or road prism.
Well developed terrace surfaces inset between valley margins. Diameter of riparian cottonwoods trends from saplings on floodplain to 4" to 8" diameter on higher terraces.

Reach Geomorphology Reach starts at confluence with Pine Creek. Pine Creek contributes up to 50 % of flow and channel widths increase downstream of confluence.
On left margin, reach is bounded by point bar, terrace surface, and sediments derived from Pine Creek. Pine Creek does not generate debris flows, but there is a large well vegetated and stable sediment wedge at the mouth of drainage. On right margin, channel bounded by road or Pine Creek Campground.
Do not see scouring from 1995 flood, deposition on high surface from 1995 flood, or large angular substrate from debris inputs.

Bank Stability Bank stability high along left edge of channel.
On right edge (road side) bank hardened with rip rap, and stable.

Woody Debris Woody debris not observed in channel. Wood loading from Pine Creek not observed. Wood recruitment potential will increase as intermediate age cottonwoods mature.

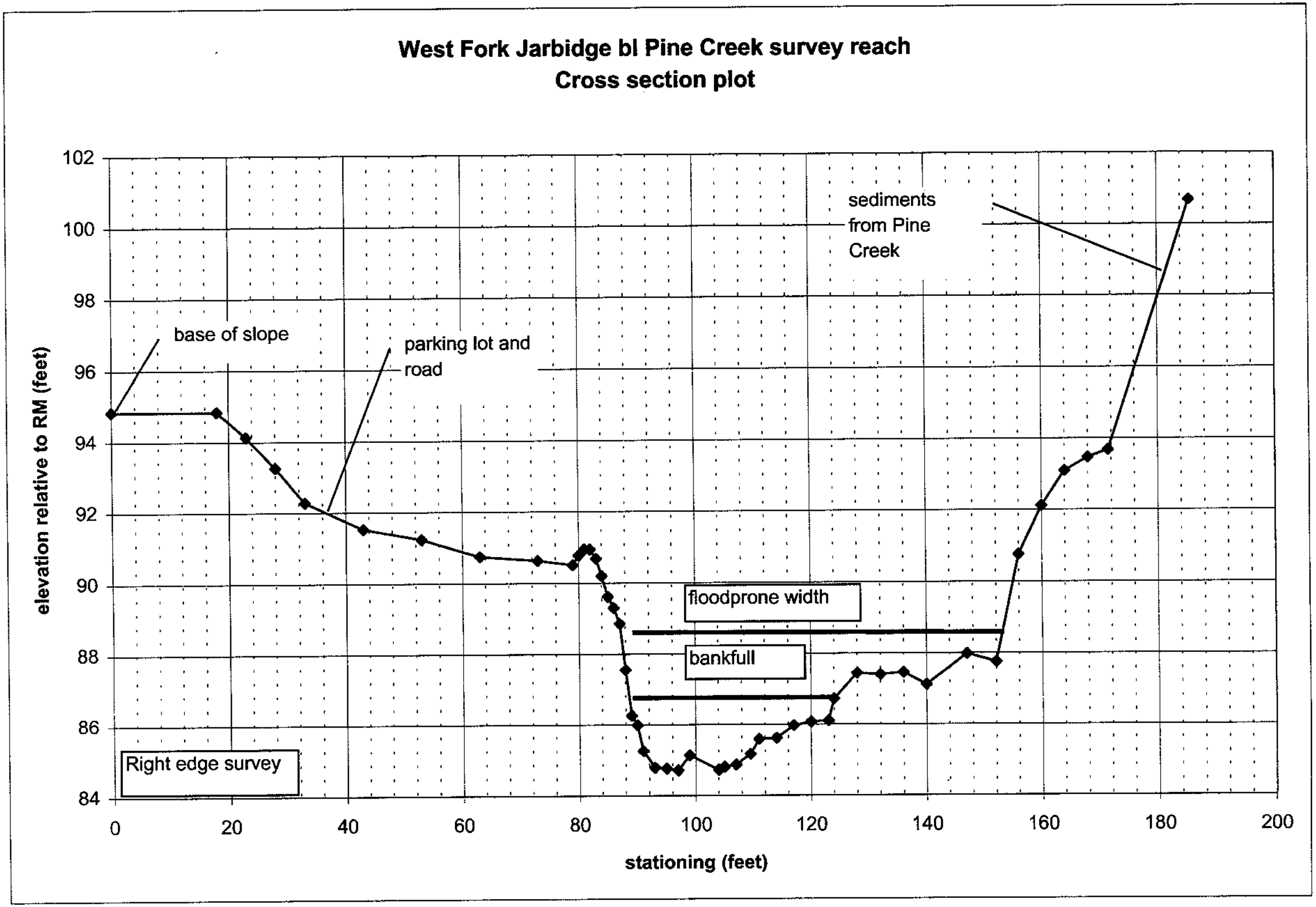
Pools Reach is located on a meander bend. Pools not observed in reach.

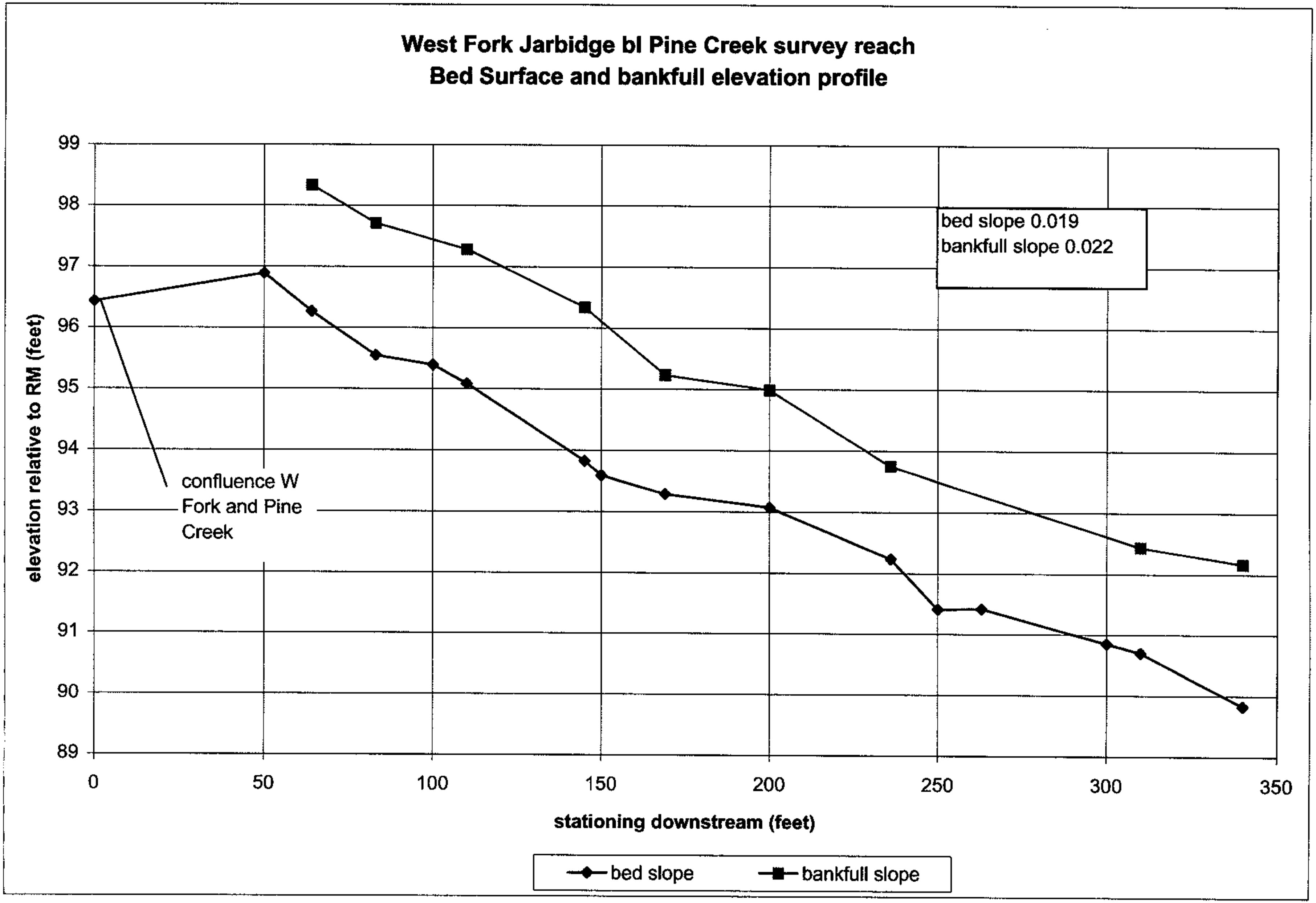
Rosgen Classification Data

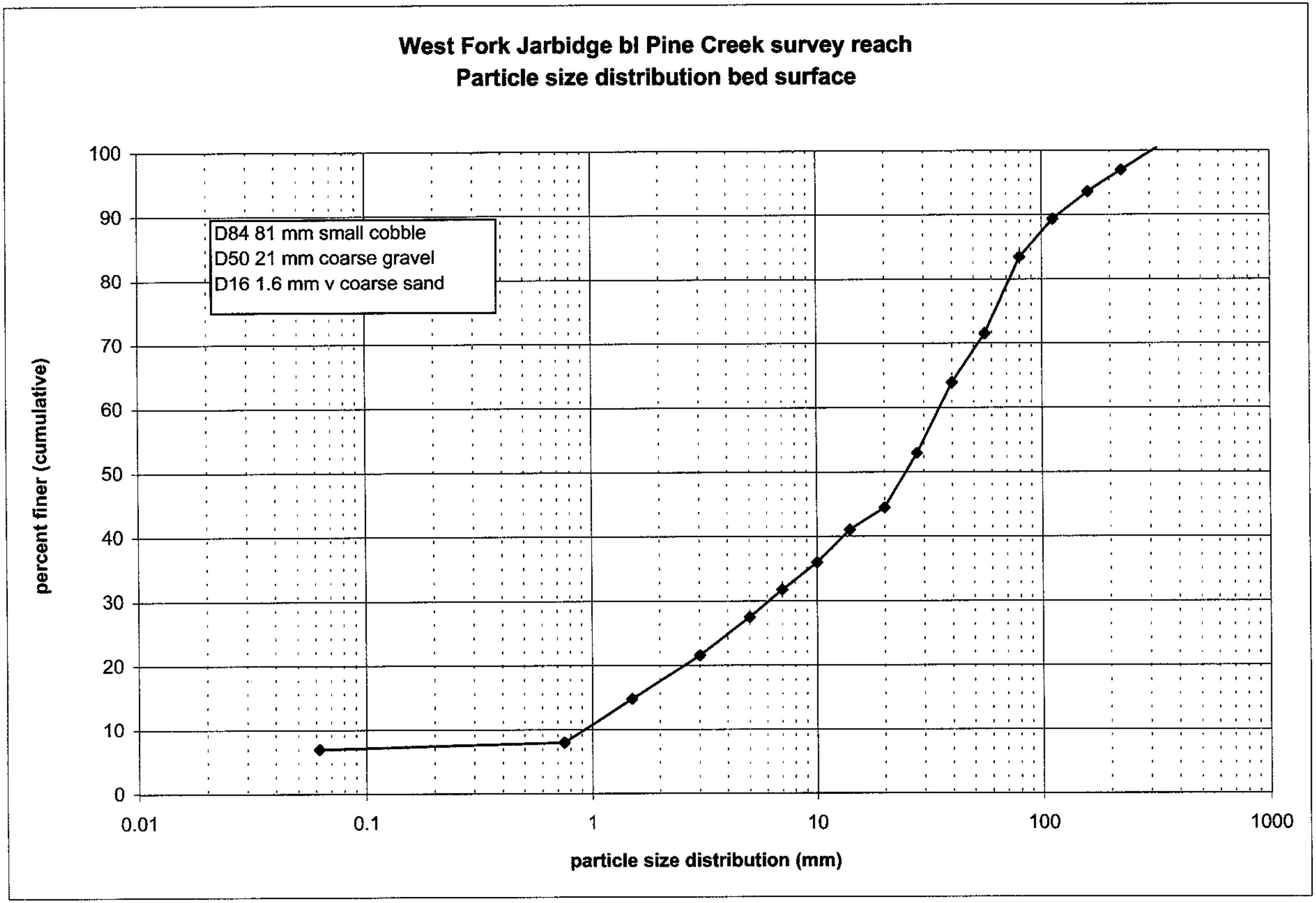
Cross section form	Uniform run located on meander bend
Bankfull width	36 feet
Mean bankfull depth	1.55 feet
Maximum bankfull depth	2.0 feet
Floodprone width	65 feet
Bed slope	0.019
Bankfull slope	0.022
Bed materials (D50)	21 mm
Sinuosity	1.2 est
Width/Depth ratio	23
Entrenchment ratio	1.8

Rosgen stream type B4

Summary Local reach is dominated by fluvial processes.
Hillslope and debris sediment inputs not observed.
Reach has well expressed bankfull indicators.
Riparian vegetation shows increasing age progression with increase in elevation of fluvial surface.
Reach does not exhibit recent incision.


West Fork Jarbidge bl Pine Creek survey reach
Cross section plot
elevation relative to RM (feet)
102
100
98
96
94
92
90
88
86
84
0
20
40
60
80
100
120
140
160
180
200
stationing (feet)
base of slope
parking lot and road
sediments from Pine Creek
floodprone width
bankfull
Right edge survey


West Fork Jarbidge bl Pine Creek survey reach
Bed Surface and bankfull elevation profile
elevation relative to RM (feet)
99
98
97
96
95
94
93
92
91
90
89
0
50
100
150
200
250
300
350
stationing downstream (feet)
confluence W Fork and Pine Creek
bed slope 0.019
bankfull slope 0.022
bed slope
bankfull slope


West Fork Jarbidge bl Pine Creek survey reach
Particle size distribution bed surface
D84 81 mm small cobble
D50 21 mm coarse gravel
D16 1.6 mm v coarse sand
percent finer (cumulative)
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
particle size distribution (mm)

Reach/Length	West Fork Jarbidge River ds Bonanza Gulch	500 feet
Survey Date	6-Nov-01	
Stream Order/ Reach Elevation	3 rd order	6440 feet

Geomorphic Setting Reach is representative of channel flowing through toe of debris fan sediments. Bonanza Gulch active in 1995 event and large source of sediment. Incised meander pattern, debris fan forces channel to opposite valley margin. Distal portion of debris fan located on left channel margin, opposite of Bonanza Gulch.

Reach Geomorphology Reach is steep with large bed elements input from debris flows. Locally mid channel bars and channel braiding where sediment inputs are large. On left margin channel bounded by debris sediments or bedrock veneered with colluvium. On right margin channel bounded by toe of debris fan. Poorly vegetated bar surfaces inset between active channel side slopes. Debris sediments have wide range in size distribution - large angular substrate down to fine sand through silt fractions - poorly sorted. Where channel forced to valley margin, bedrock, colluvium, and talus slopes input large angular substrate.

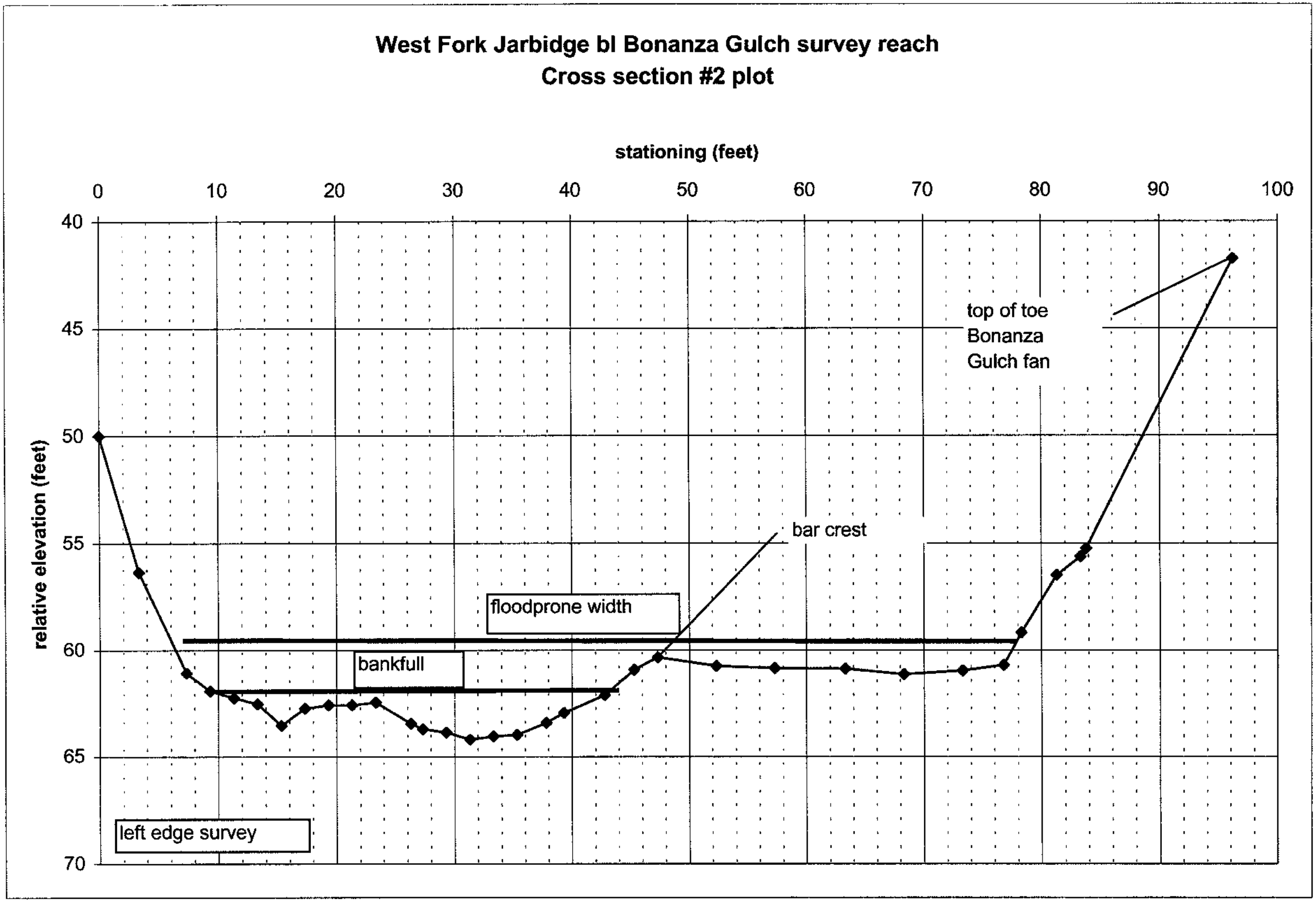
Bank Stability Side slopes of valley are actively eroding and are large source of sediment. Large debris fan erosion sources observed in all areas where active channel cuts through fans.

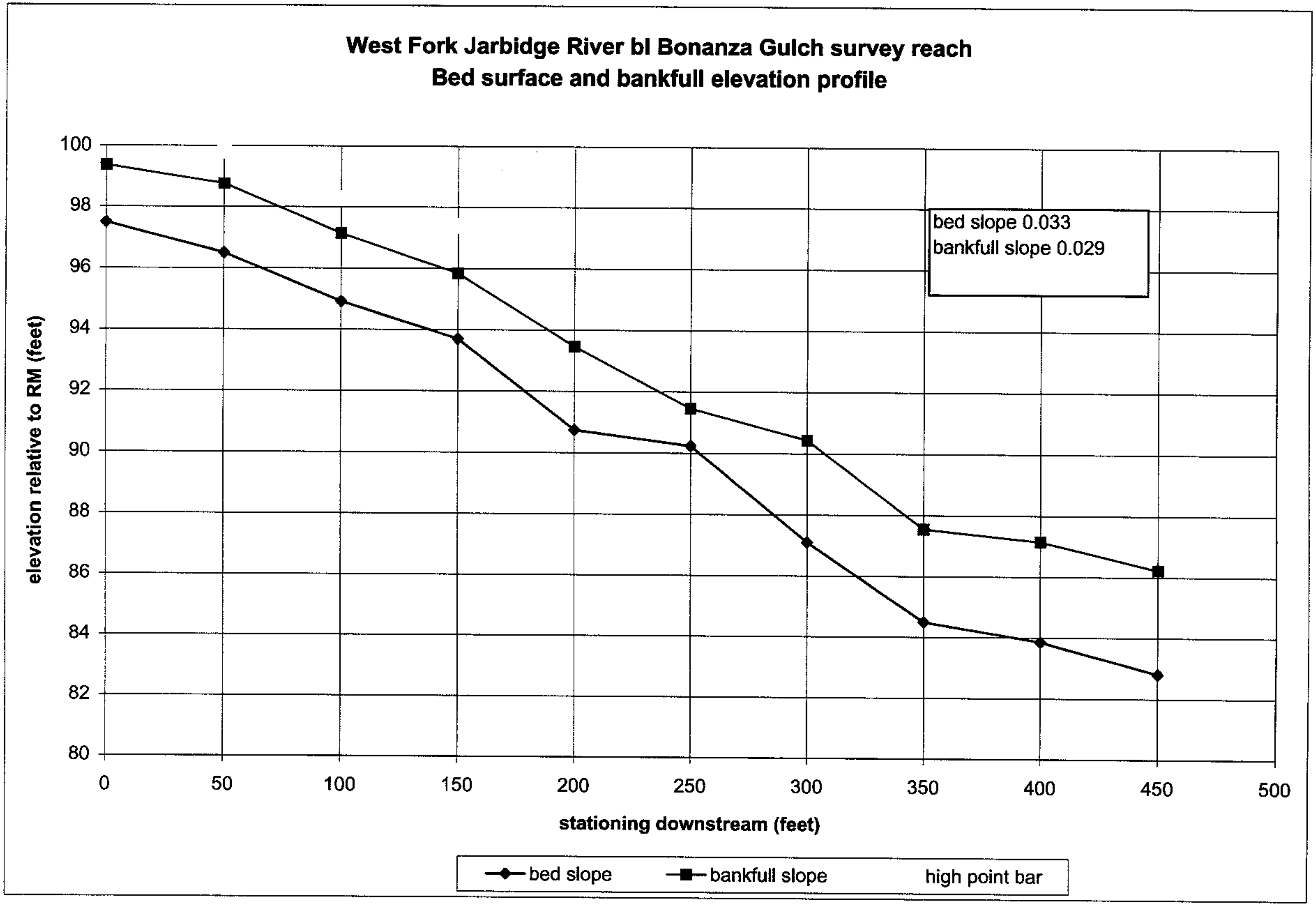
Woody Debris Breached woody debris jams located through reach. Large wood introduced from bank areas where active erosion is undermining trees. Does not appear that Bonanza Gulch is active contributor of large woody debris. Wood recruitment potential high due to unstable slopes.

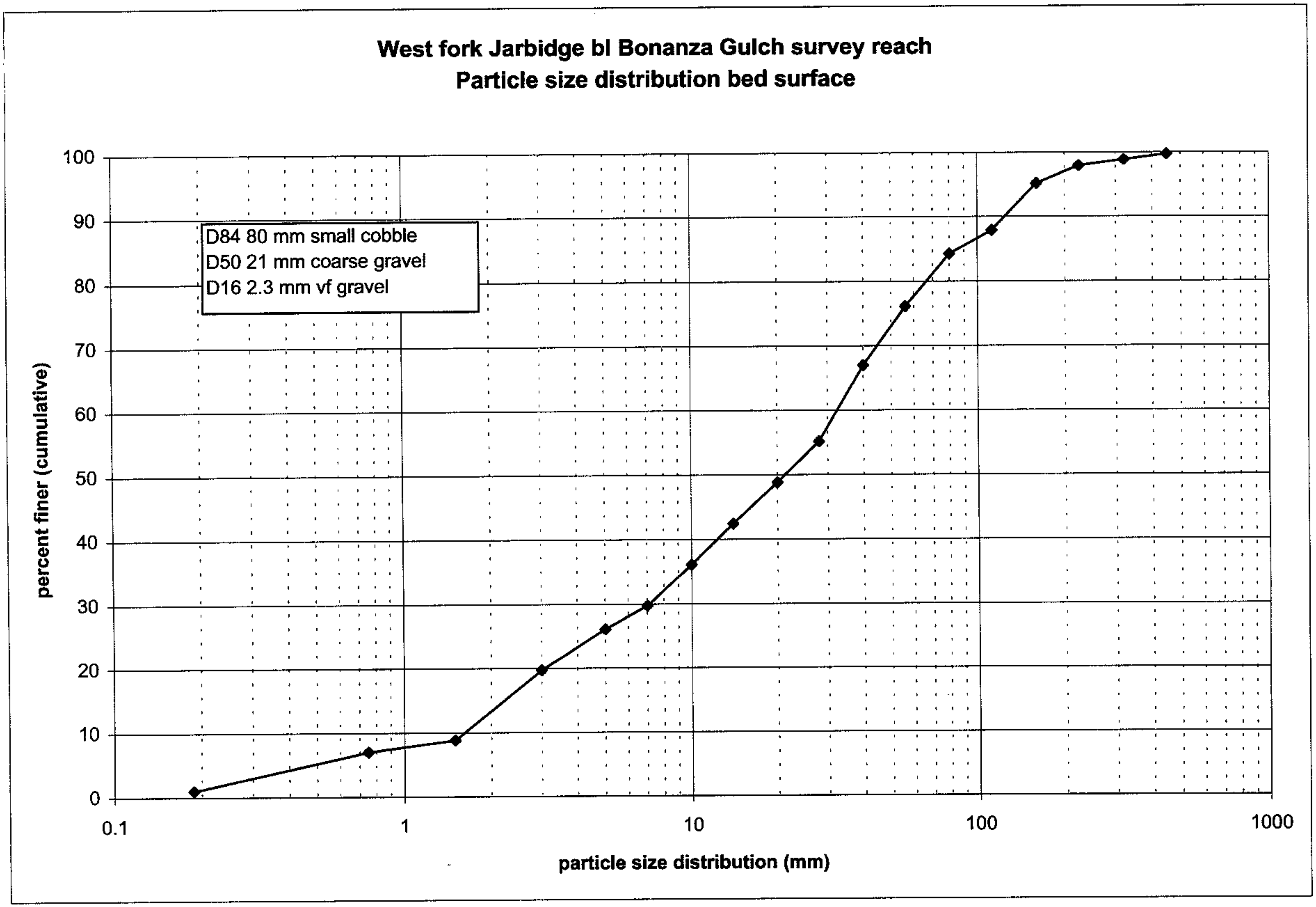
Pools Small pocket water and scour pools observed through reach. Large substrate and wood increases instream hydraulic and habitat diversity.

Rosgen Classification Data	
Cross section form	deep run bounded by recent, elevated bar deposits
Bankfull width	33.5 feet
Mean bankfull depth	1.5 feet
Maximum bankfull depth	2.3 feet
Floodprone width	72 feet
Bed slope	0.033
Bankfull slope	0.029
Bed materials (D50)	21 mm
Sinuosity	1.1 est
Width/Depth ratio	22
Entrenchment ratio	2.1
Rosgen stream type	B4

Summary Reach is dominated by hillslope and debris flow processes. Reach is representative of other reaches flowing through debris fan sediments. Primary source for wood recruitment into channel environment.


West Fork Jarbidge bl Bonanza Gulch survey reach
Cross section #2 plot
stationing (feet)
0
10
20
30
40
50
60
70
80
90
100
relative elevation (feet)
40
45
50
55
60
65
70
top of toe Bonanza Gulch fan
bar crest
floodprone width
bankfull
left edge survey


West Fork Jarbidge River bl Bonanza Gulch survey reach
Bed surface and bankfull elevation profile
bed slope 0.033
bankfull slope 0.029
elevation relative to RM (feet)
100
98
96
94
92
90
88
86
84
82
80
0
50
100
150
200
250
300
350
400
450
500
stationing downstream (feet)
bed slope
bankfull slope
high point bar


West fork Jarbidge bl Bonanza Gulch survey reach
Particle size distribution bed surface
D84 80 mm small cobble
D50 21 mm coarse gravel
D16 2.3 mm vf gravel
percent finer (cumulative)
0
10
20
30
40
50
60
70
80
90
100
0.1
1
10
100
1000
particle size distribution (mm)

Reach/Length	West Fork Jarbidge River in vicinity of Mahoney Guard Station	600 feet
Survey Date	6-Nov-01	
Stream Order/ Reach Elevation	3rd order	6040 feet

Geomorphic Setting Depositional area, large sediment storage in floodplain environment. Alluvial basin formed by lower valley slope and bedrock constriction in valley upstream of Jack Creek. Some aquatic floodplain habitat, however most of floodplain area covered with recent gravel deposits.

High fluvial terraces occur in larger reach area and where channel located against these surfaces, they are large and active sediment sources.

Reach Geomorphology Alluvial channel, restricted meandering pattern. Widest valley width in project area. Channel is excavating through recent alluvial flood gravels. Substrate is well rounded and well sorted. Riparian community contains high percentage of willow thickets. Floodplain spring channel in reach - flowing with water derived from ground water inflow. Channel flows into main active channel.

Bank Stability Most channel banks are formed in poorly or unvegetated gravel bars. Banks materials form movable channel boundary, but are not active sediment sources due to depositional character of reach.

Woody Debris Limited areas of wood accumulation in channel. Shrub riparian community may form bank margins and create undercut areas. Limited wood recruitment potential.

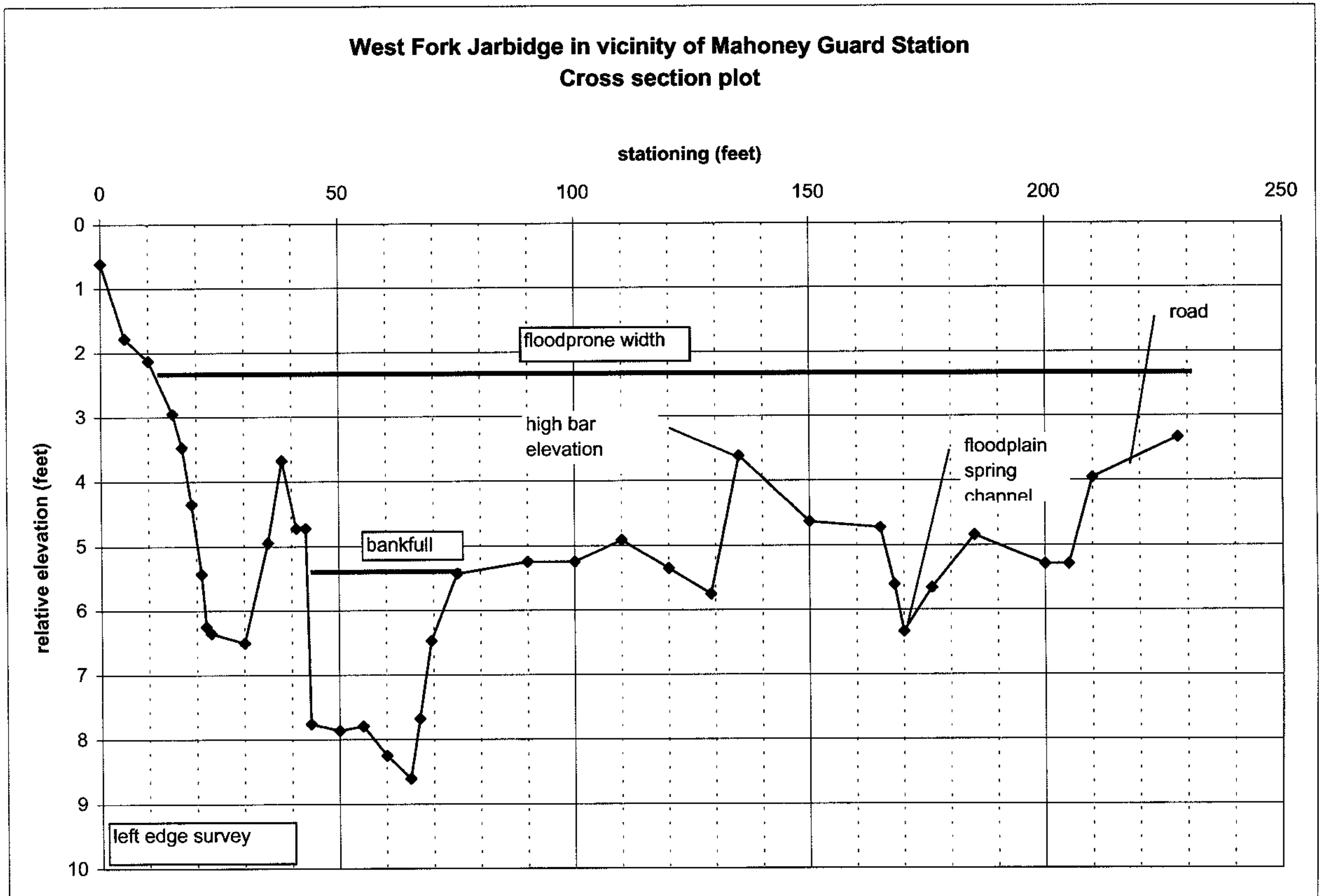
Pools Generally very uniform channel units with very limited pool development. Some bank margin pools where riparian vegetation occurs.

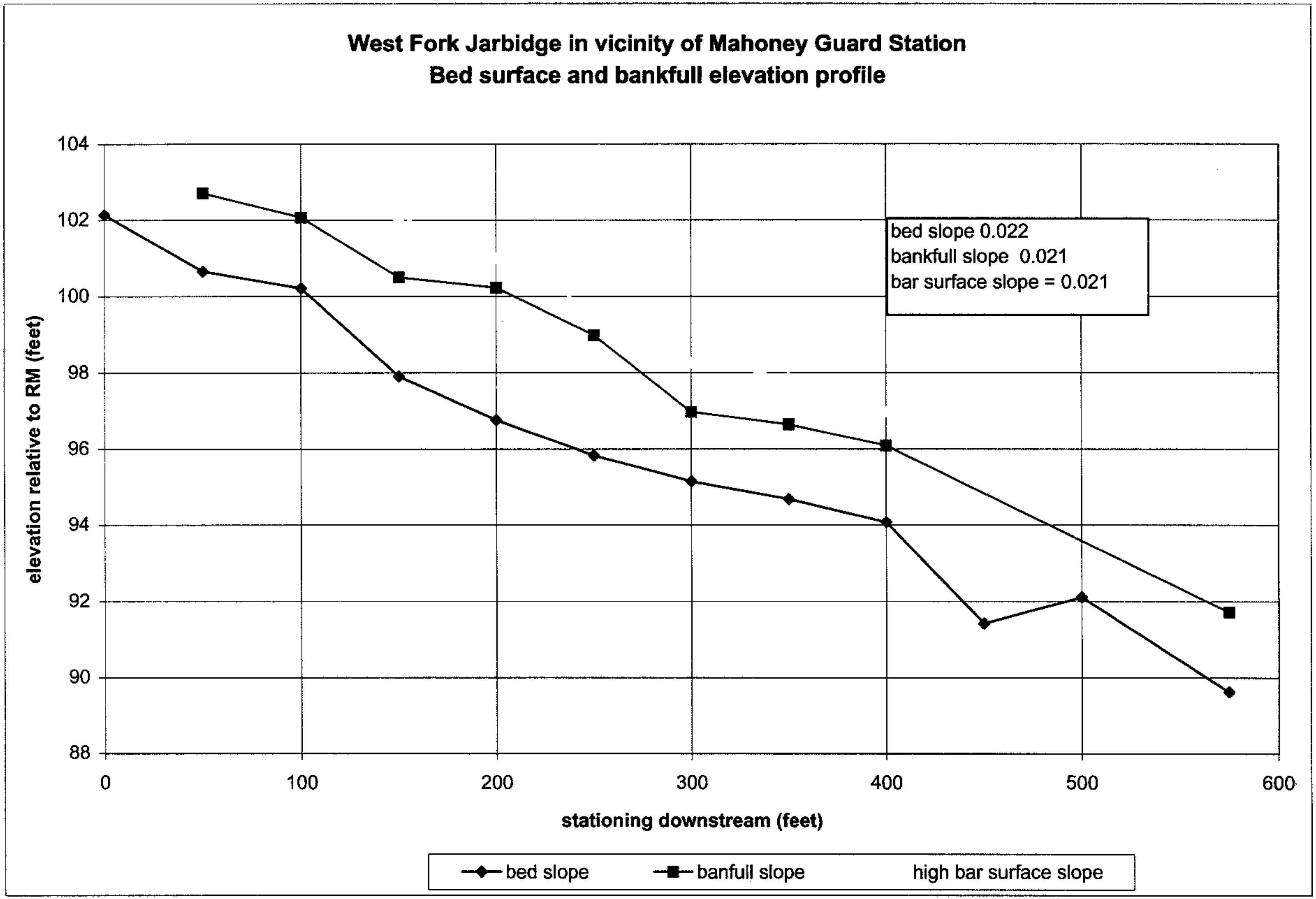
Rosgen Classification Data

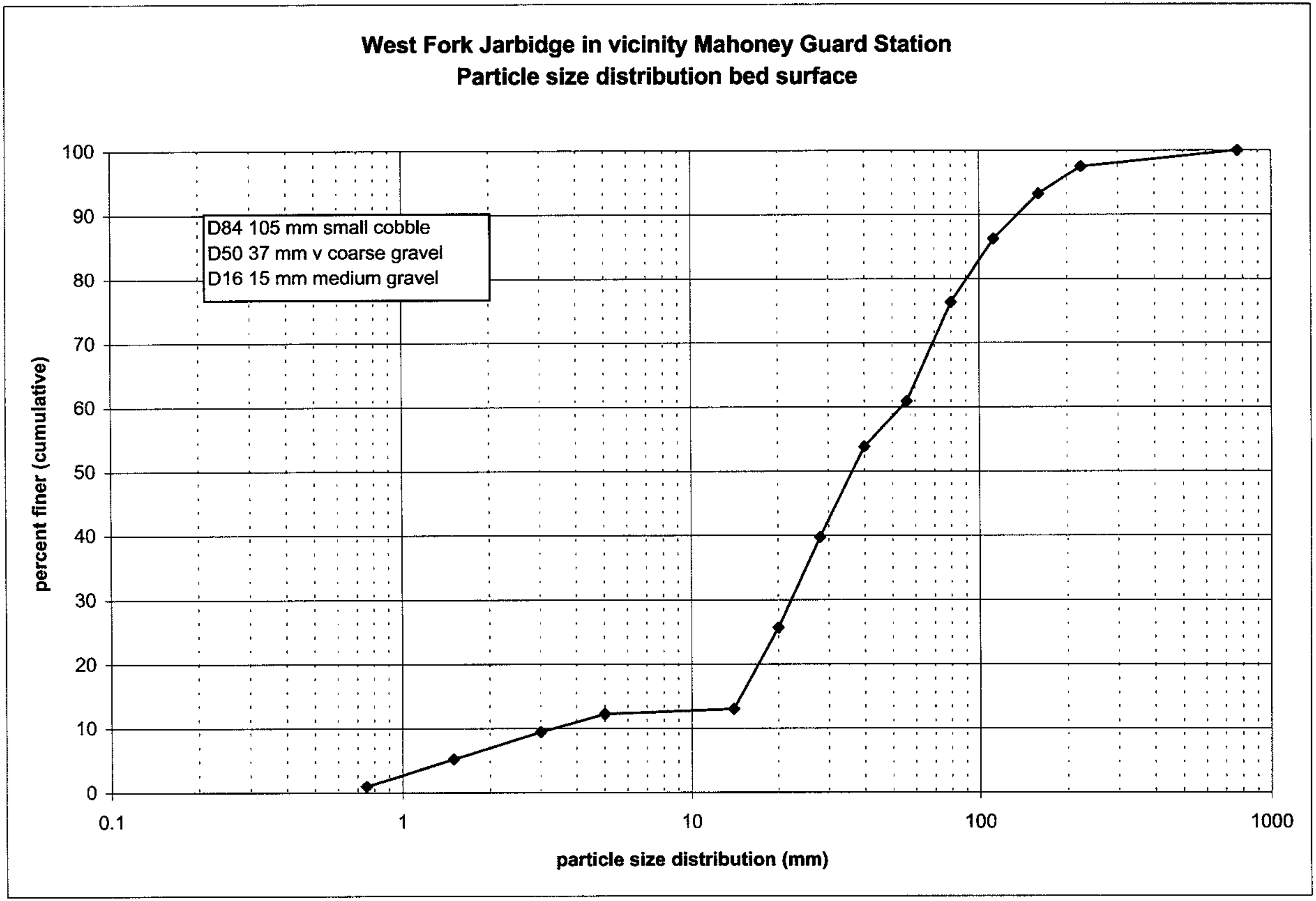
Cross section form	uniform run flowing through gravels
Bankfull width	31 feet
Mean bankfull depth	2.1 feet
Maximum bankfull depth	3.2 feet
Floodprone width	240 feet
Bed slope	0.022
Bankfull slope	0.021
Bed materials (D50)	37 mm
Sinuosity	1.3 est
Width/Depth ratio	14.8
Entrenchment ratio	7.7

Rosgen stream type C4b

Summary Survey reach is representative of depositional reach starting downstream of Moore Gulch. Large sediment storage area. Reach is dominated by fluvial processes. Locally channel braids. Iron oxide staining from Greylock adit still evident in gravels.


West Fork Jarbidge in vicinity of Mahoney Guard Station
Cross section plot
stationing (feet)
0
50
100
150
200
250
relative elevation (feet)
0
1
2
3
4
5
6
7
8
9
10
floodprone width
high bar
elevation
bankfull
floodplain
spring
channel
road
left edge survey


West Fork Jarbidge in vicinity of Mahoney Guard Station
Bed surface and bankfull elevation profile
104
102
100
98
96
94
92
90
88
elevation relative to RM (feet)
0
100
200
300
400
500
600
stationing downstream (feet)
bed slope 0.022
bankfull slope 0.021
bar surface slope = 0.021
bed slope
banfull slope
high bar surface slope


West Fork Jarbidge in vicinity Mahoney Guard Station
Particle size distribution bed surface
D84 105 mm small cobble
D50 37 mm v coarse gravel
D16 15 mm medium gravel
percent finer (cumulative)
100
90
80
70
60
50
40
30
20
10
0
0.1
1
10
100
1000
particle size distribution (mm)

Reach/Length	West Fork Jarbidge River us of Jack Creek	500 feet
Survey Date	6-Nov-01	
Stream Order/ Reach Elevation	3 rd order	5950 feet

Geomorphic Setting Restricted valley width. Channel is incised meandering stream. Valley margin bounded by bedrock and there are inputs of large substrate elements from slopes.

Reach Geomorphology Incised channel with generally stable side slopes. Inset floodplains located between active channel and valley slopes. Low sinuosity channel planform.

Bank Stability Bank stability is generally high with dense stands of riparian and upland vegetation.

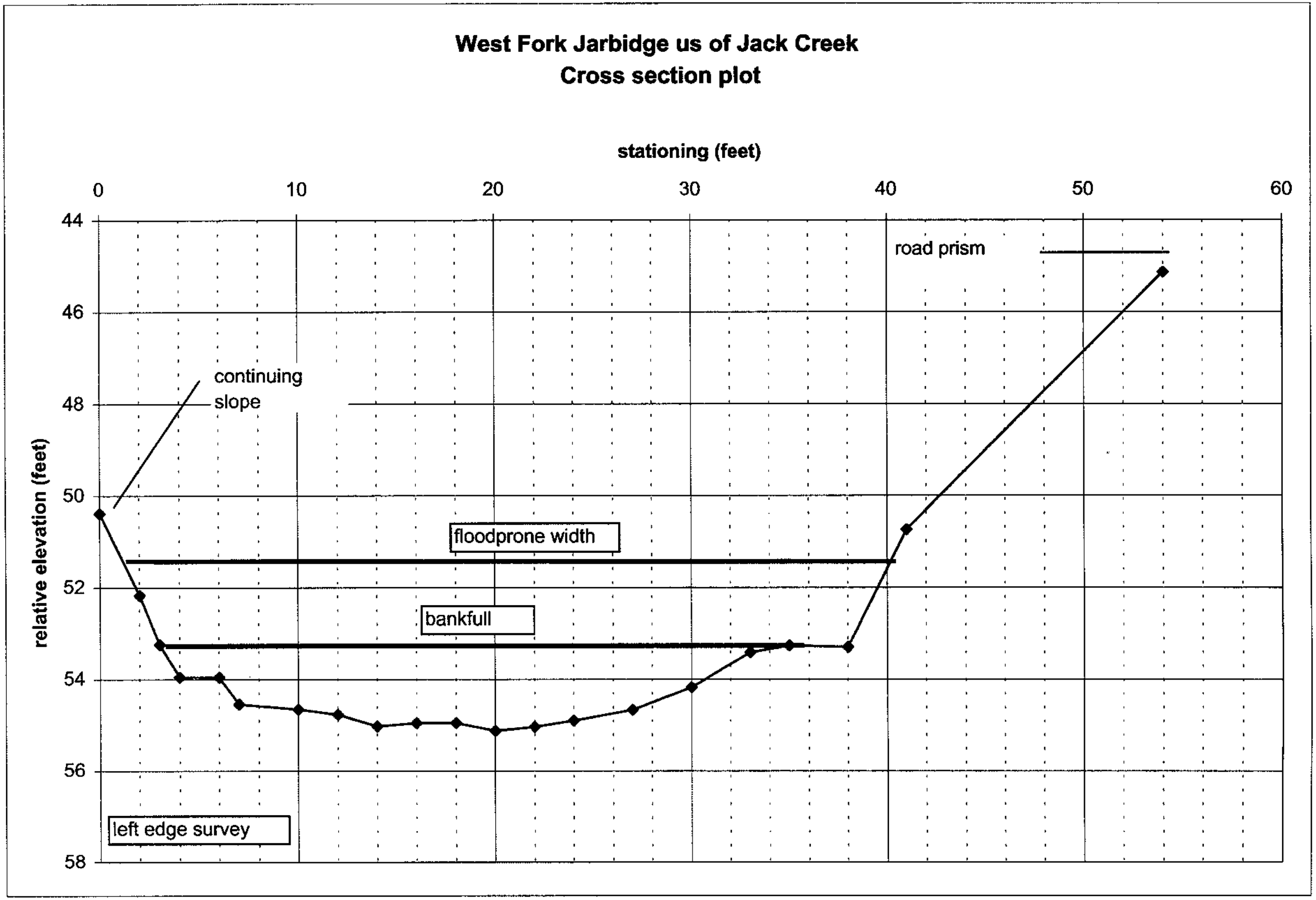
Woody Debris Woody debris rarely observed in channel. Wood recruitment potential is good but slopes are stable and generally isolated from high flows.
Transport reach and introduced wood may move through system. Sediment wedge produced by Jack Creek at lower end of reach. Jack Creek does not exhibit debris fan.

Pools Small pocket, scour, and backwater pools. Habitat and hydraulic diversity associated with large substrate elements.

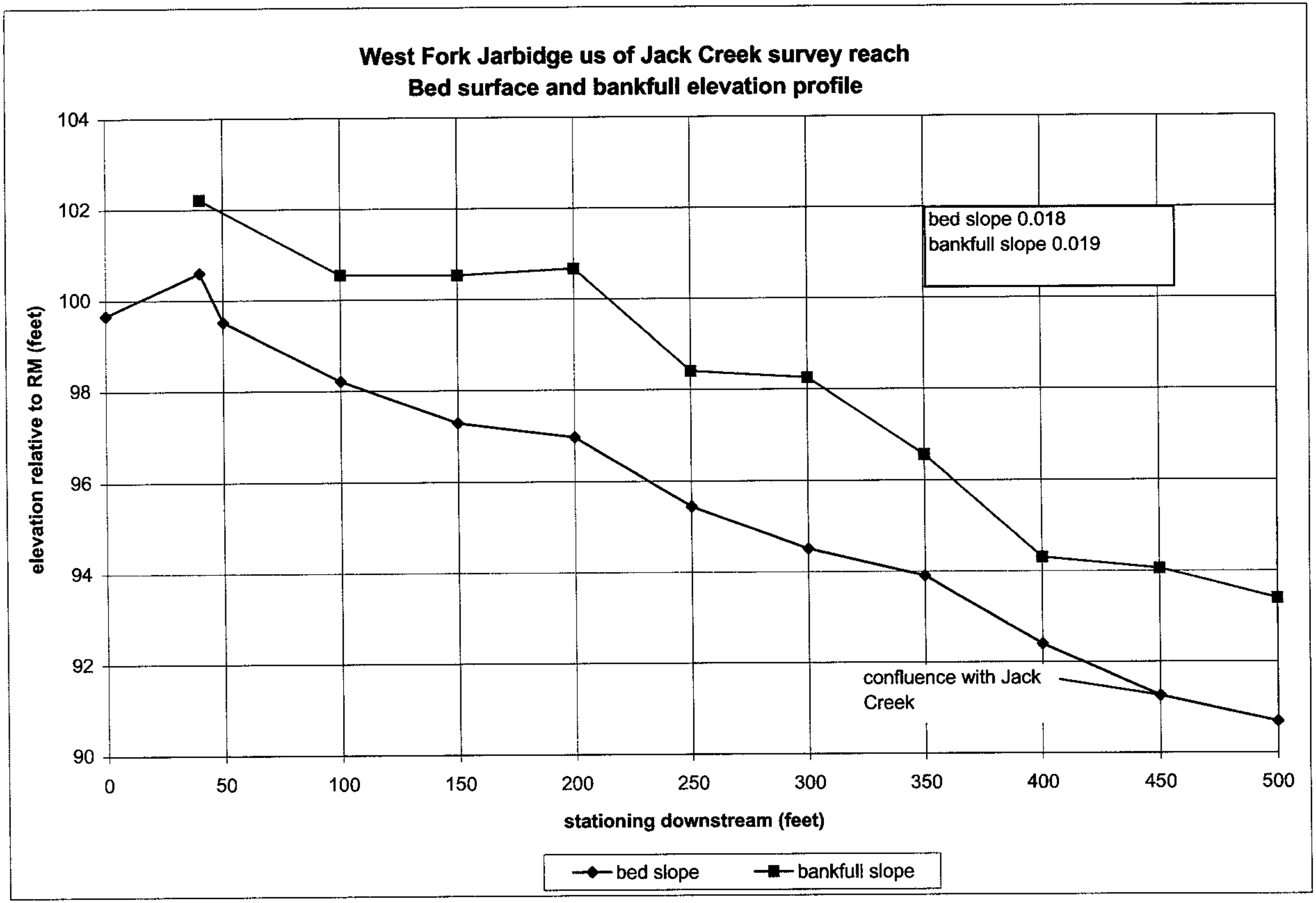
Rosgen Classification Data

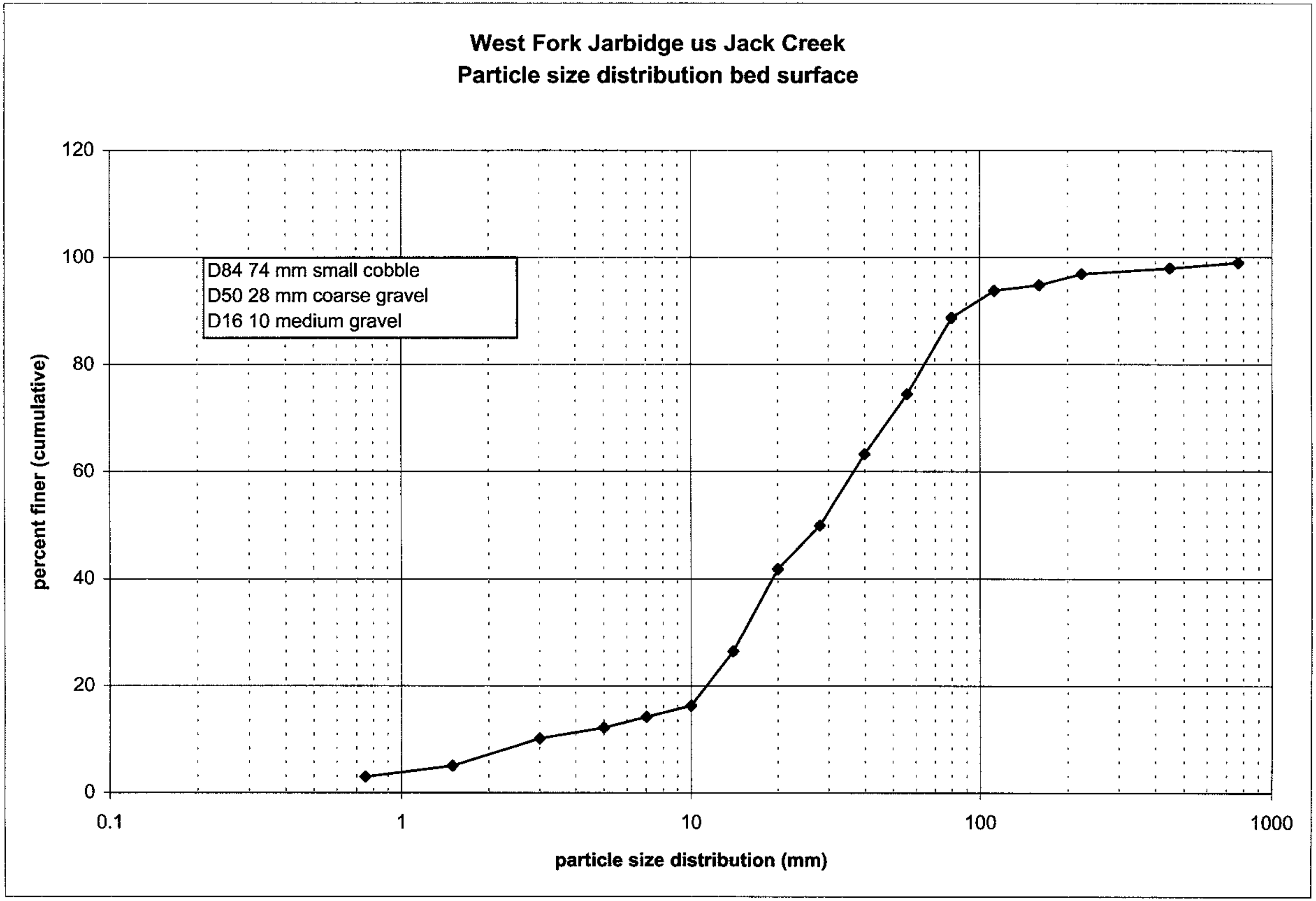
Cross section form	Uniform section with inset flooplain surface
Bankfull width	32 feet
Mean bankfull depth	1.5 feet
Maximum bankfull depth	1.9 feet
Floodprone width	39 feet
Bed slope	0.018
Bankfull slope	0.019
Bed materials (D50)	28 mm
Sinuosity	1.1 est
Width/Depth ratio	21
Entrenchment ratio	1.2
Rosgen stream type	F4

Summary Reach is characteristic on long channel segment from downstream of Mahoney guard station to confluence with Deer Creek.
Reach has high stability and does not exhibit scouring or deposition on high surfaces from 1995 flood. Road chronic sediment source throughout reach.
Reach is dominated by fluvial processes, but hillslope inputs of large substrate form key component of channel.



West Fork Jarbidge us of Jack Creek
Cross section plot
stationing (feet)
0
10
20
30
40
50
60
44
46
48
50
52
54
56
58
relative elevation (feet)
road prism
continuing
slope
floodprone width
bankfull
left edge survey


West Fork Jarbidge us of Jack Creek survey reach
Bed surface and bankfull elevation profile
bed slope 0.018
bankfull slope 0.019
confluence with Jack Creek
elevation relative to RM (feet)
stationing downstream (feet)
104
102
100
98
96
94
92
90
0
50
100
150
200
250
300
350
400
450
500
bed slope
bankfull slope


West Fork Jarbidge us Jack Creek
Particle size distribution bed surface
D84 74 mm small cobble
D50 28 mm coarse gravel
D16 10 medium gravel
120
100
80
60
40
20
0
percent finer (cumulative)
0.1
1
10
100
1000
particle size distribution (mm)

Reach/Length East Fork Jarbidge River ab Robinson Creek 300 feet
Survey Date 7-Nov-01
Stream Order/ Reach Elevation

Geomorphic Setting Wide alluvial valley with multiple terrace surfaces. Historic beaver complexes observed throughout valley floor. Do not see large sediment storage zones. Channel intermittently flows over bedrock. Moderate grazing impacts and potentially historic impacts through reach.

Reach Geomorphology Straight reach with bedrock forming bed up and downstream of survey reach. Six to 10 inch cottonwoods on terraces bounding channel. Active channel has limited access to valley width during low recurrence interval floods. Limited bar development in reach. Scattered large boulders through reach.
Channel appears moderately incised.
No direct evidence for scouring or deposition on high surfaces during recent flood history.

Bank Stability Banks have a high percentage of riparian vegetation and are stable. There are scoured bank margins which are minor sediment sources.

Woody Debris Limited in channel wood accumulations were observed, but wood recruitment potential is high. There are large area with shrub riparian vegetation.

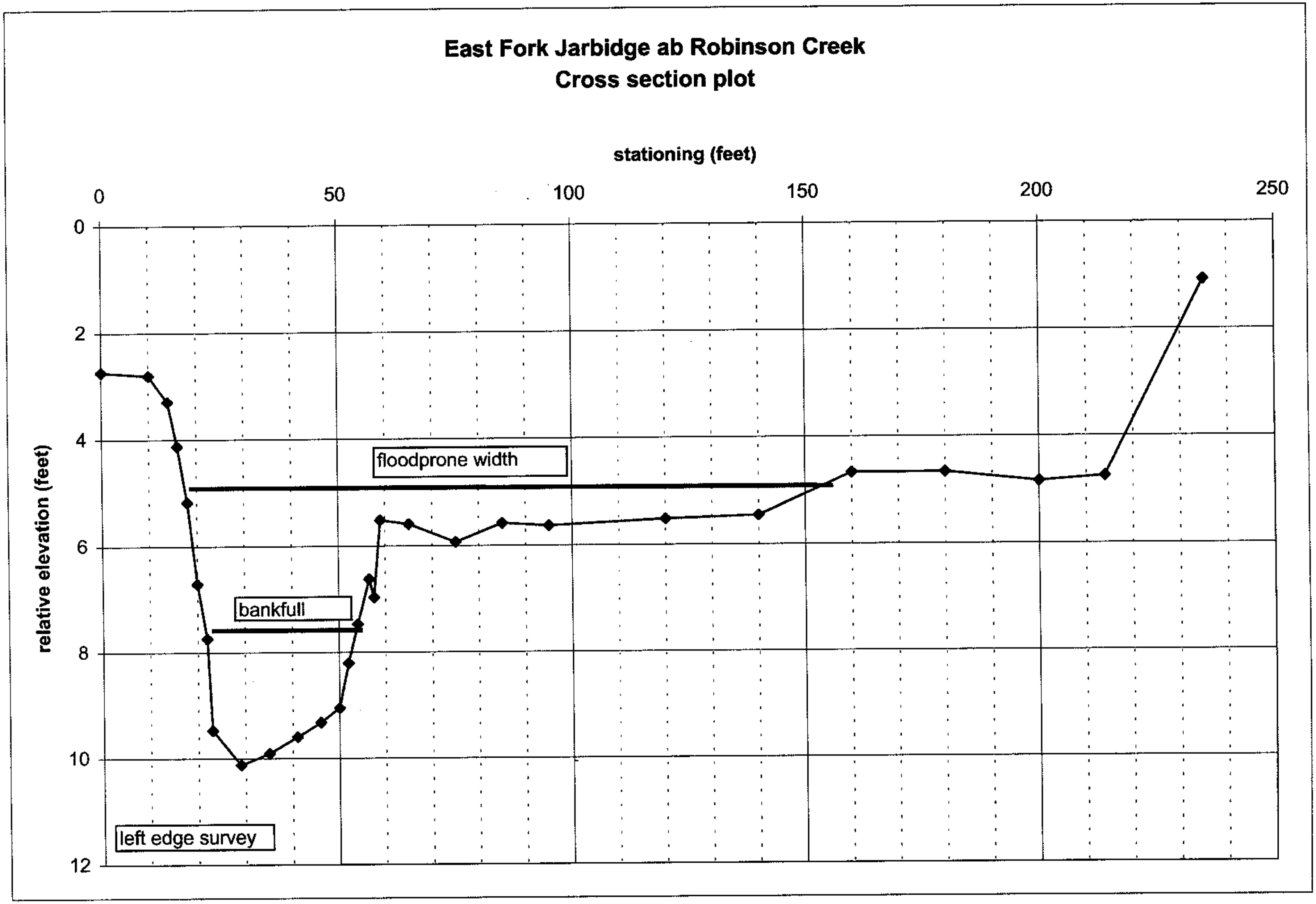
Pools Scour and pocket pools occur in association with inchannel boulders. Trench pools occur in most areas with a bedrock channel. Larger cross channel width pools related to channel planform are common.

Rosgen Classification Data
Cross section form Deep run with some backwater from downstream increase in bed elevation

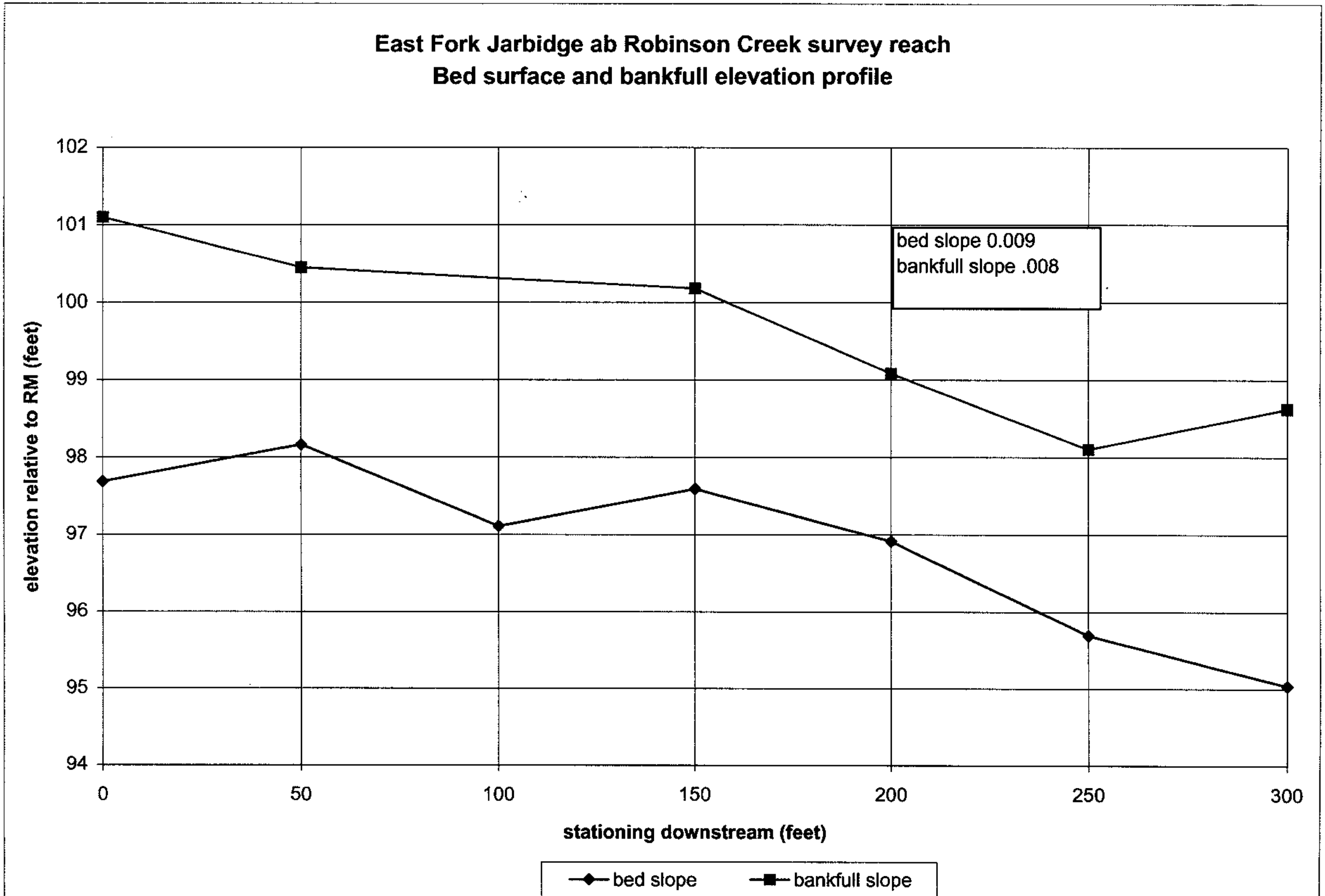
Bankfull width	32 feet
Mean bankfull depth	1.8 feet
Maximum bankfull depth	2.6 feet
Floodprone width	138 feet
Bed slope	0.009
Bankfull slope	0.008
Bed materials (D50)	27 mm
Sinuosity	1.3 est
Width/Depth ratio	18
Entrenchment ratio	4.3

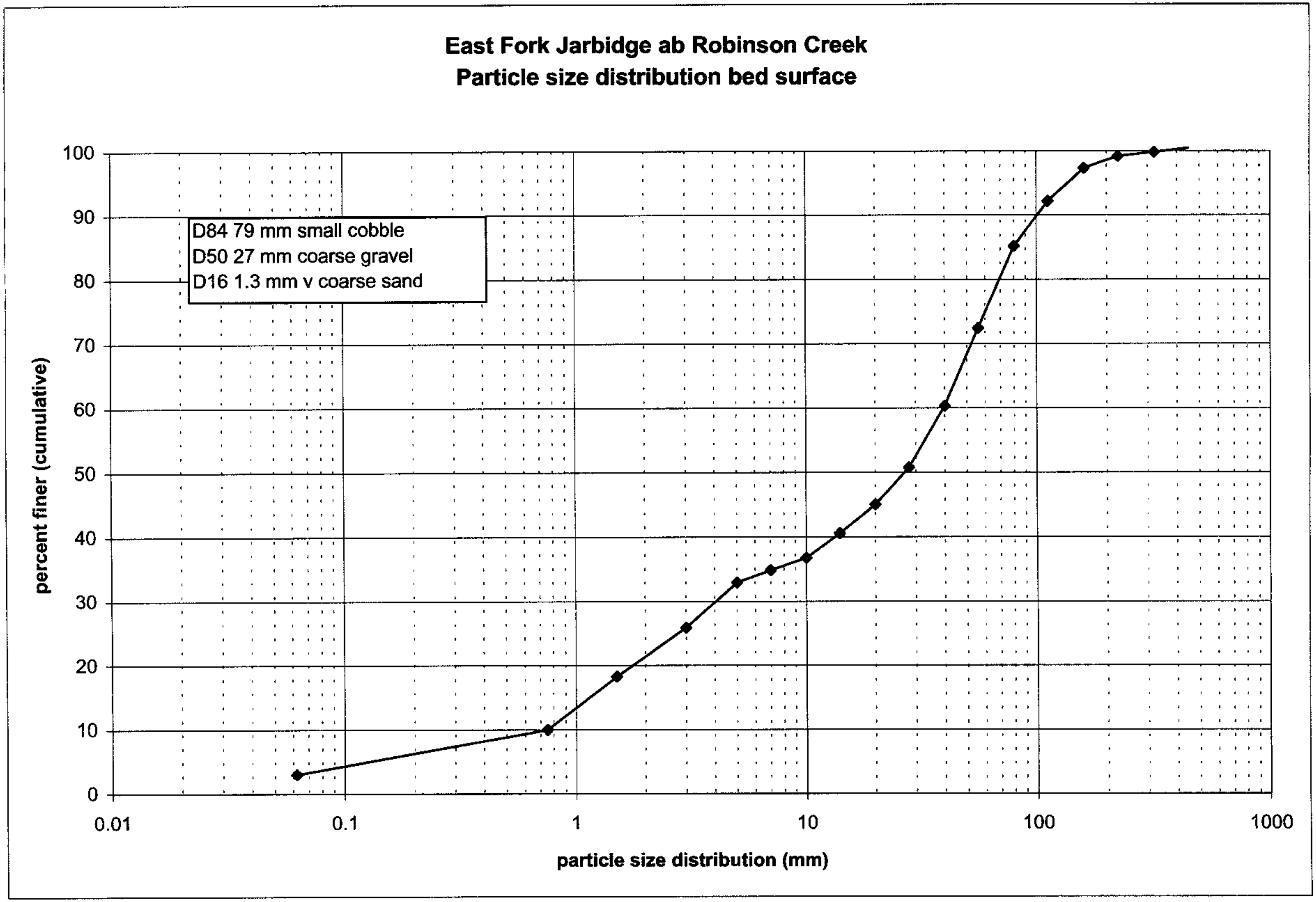
Rosgen stream type C4

Summary Greatest observation of macroinvertebrates observed in this reach when pebble counts completed. Fluvial processes dominate in reach.



East Fork Jarbidge ab Robinson Creek
Cross section plot
stationing (feet)
0
50
100
150
200
250
relative elevation (feet)
0
2
4
6
8
10
12
floodprone width
bankfull
left edge survey


East Fork Jarbidge ab Robinson Creek survey reach
Bed surface and bankfull elevation profile
bed slope 0.009
bankfull slope .008
elevation relative to RM (feet)
102
101
100
99
98
97
96
95
94
0
50
100
150
200
250
300
stationing downstream (feet)
bed slope
bankfull slope

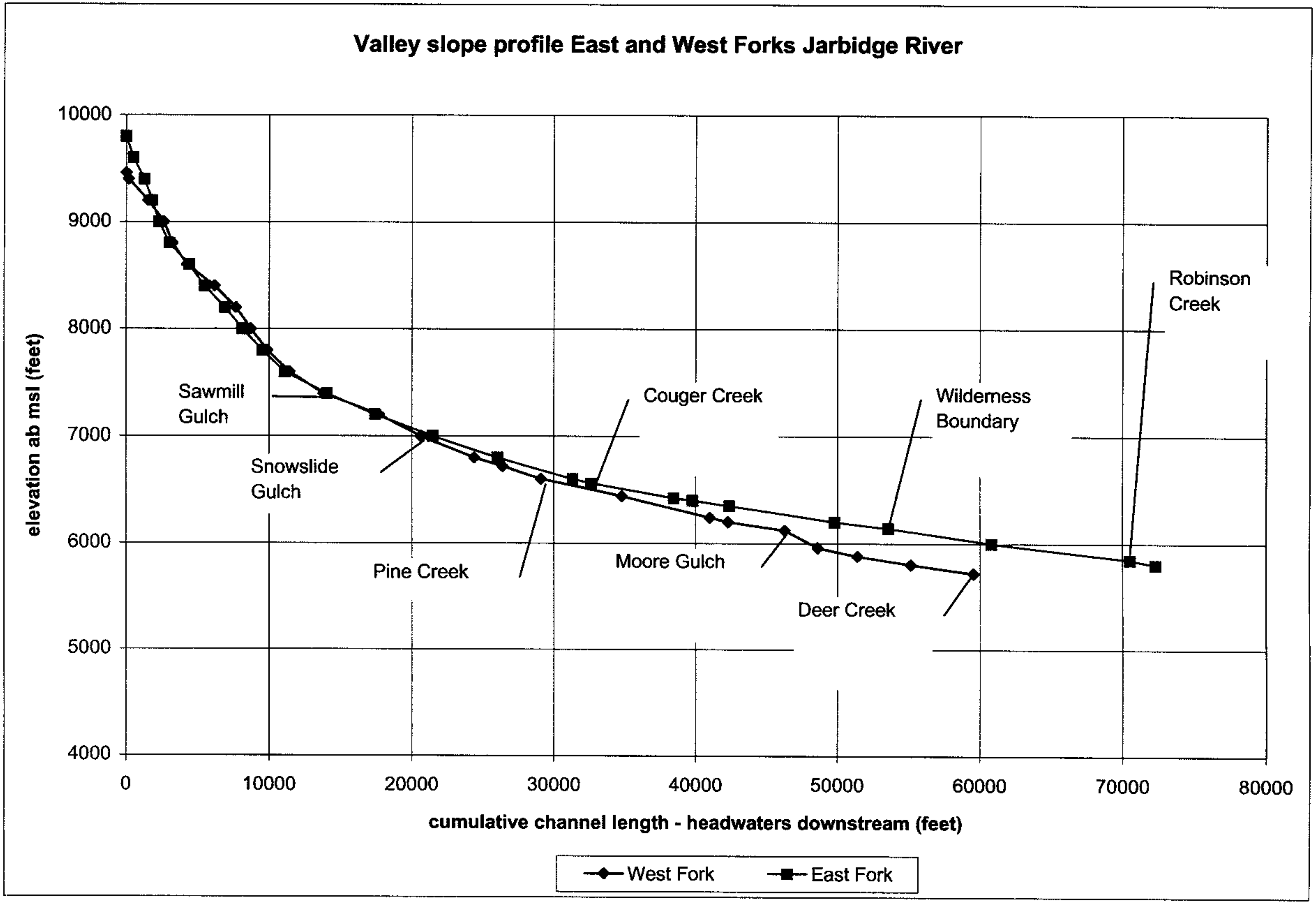

East Fork Jarbidge ab Robinson Creek
Particle size distribution bed surface
D84 79 mm small cobble
D50 27 mm coarse gravel
D16 1.3 mm v coarse sand
percent finer (cumulative)
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
particle size distribution (mm)

APPENDIX G

Valley Slope West Fork Jarbidge River

Appendix G: Valley Slope - West Fork Jarbidge River			
elevation feet	distance along channel feet	cumulative distance	feature
9460	0	0	divide us Jarbidge lake
9400	160	160	Jarbidge lake
9200	1360	1520	
9000	1100	2620	
8800	600	3220	
8600	1000	4220	
8400	1940	6160	
8200	1500	7660	
8000	1040	8700	
7800	1160	9860	
7600	1540	11400	1st unnamed trib us Sawmill
7400	2400	13800	confluence Sawmill
7200	3900	17700	us Dry Gulch
7000	2920	20620	us Snowslide
6800	3760	24380	
6720	2000	26380	confluence Fox Cr
6600	2700	29080	confluence Pine Cr
6440	5700	34780	Bonanza Gulch
6240	6200	40980	Bourne Gulch
6200	1300	42280	us part townsite
6120	4000	46280	Moore Gulch
5960	2300	48580	
5880	2800	51380	confluence Jack Cr
5800	3760	55140	
5720	4400	59540	confluence Deer Cr

Appendix G: Valley Slope - East Fork Jarbidge River			
Elevation feet	distance along channel feet	cumulative distance	feature
9800	0	0	
9600	500	500	
9400	760	1260	
9200	560	1820	
9000	460	2280	
8800	720	3000	
8600	1380	4380	
8400	1100	5480	
8200	1400	6880	
8000	1220	8100	
7800	1440	9540	
7600	1540	11080	start named East Fork
7400	2960	14040	
7200	3380	17420	
7000	4060	21480	
6800	4540	26020	
6600	5300	31320	
6560	1320	32640	Couger Cr
6424	5800	38440	Fall Cr
6400	1320	39760	
6350	2600	42360	Slide Cr
6200	7420	49780	
6140	3800	53580	wilderness boundary
6000	7240	60820	
5850	9680	70500	Robinson Cr
5800	1800	72300	
5600	8700	81000	
5400	9800	90800	
5310	4800	95600	Dave Cr



Valley Slope - West Fork Jarbidge River

APPENDIX H

Suspended Sediment and Bedload Discharge Data

Appendix H: Raw Sediment Discharge Date for USGS station 13162225
Jarbidge River bl Jarbidge, NV

date	mean daily discharge cfs	TSS mg/l	Calculated TSS tons/day	Bedload discharge tons/day	Average of bedload samples	percent finer 0.062 mm	0.125 mm	0.250 mm	0.50 mm	1.0 mm	2.0 mm	4.0 mm	8.0 mm	16.0 mm	32.0 mm	64.0 mm
4/22/98	60	4	0.06	3	5.4	0	0	3.3	23.3	63.3	90	100				
4/22/98	60			7.7		0	0	3.8	27.8	56.9	79.7	97.4	100			
4/28/98	64	3	0.05	11.5	28.8	0	0	0.8	10.9	42.7	75.4	93	100			
4/28/98	64			46		0	0	0.9	8.4	29.2	58.9	78.5	92.4	100		
4/30/98	96	5	0.13	24	39.1	0	0	1.7	14.6	43.4	78.2	96.7	100			
4/30/98	96			54.2		0	0	0.9	7.8	32.7	74.2	95	100			
5/5/98	114	4	0.12	52.3	87.0	0	0	0.8	7.8	25.2	52.6	75	93.3	100		
5/5/98	114			121.7		0	0	0.4	3.7	15.7	43.4	74.6	92.6	100		
5/7/98	110	2	0.06	100.5	61.4	0	0	0.3	4.5	18.5	52.4	88.9	100			
5/7/98	110			22.2		0	0	0.9	7.6	28.1	62.9	92.3	100			
5/12/98	151		0.28	19.7	13.0	0	0	1.6	13.6	34.1	59.7	81.2	100			
5/12/98	151	7		6.3		0	0	4.8	25.8	56.5	85.5	96.8	100			
5/14/98	131		0.14	150.9	89.9	0	0	0.7	7.8	21.6	42.3	59.2	73.2	85.9	100	
5/14/98	131	4		28.8		0	0	1.4	9.9	26.6	47.5	66	91.7	100		
5/19/98	108		0.06	1.3	27.3	0	0	0	7.7	23.1	53.8	76.9	100			
5/19/98	108	2		53.2		0	0	0.4	4.9	19.8	52.9	83.6	100			
5/21/98	120		0.13	5.5	5.0	0	0	1.9	9.5	32.2	64.3	92.7	100			
5/21/98	120	4		4.5		0	0	0	11.1	40	75.6	97.8	100			
6/2/98	186		0.60	64.3	189.6	0.3	0.5	3.1	25.7	56.9	84.9	97.2	100			
6/2/98	186	12		314.8		0	0.1	1.1	8.9	26.9	47.4	64.4	78.2	89.1	100	
6/4/98	191		0.57	191.2	211.2	0.1	0.1	0.3	15.1	40.6	66.2	80.8	91.3	100		
6/4/98	191	11		231.1		0	0.1	0.5	10.7	33.3	60.8	78.6	91.9	94.4	100	
6/9/98	224	8	0.48	441.4	241.3	0	0.1	0.6	3.7	10.6	20.2	26.4	32.2	36.2	81.2	100
6/9/98	224			41.2		0.2	1.2	3.6	21.4	48.4	78.5	92.5	96.8	100		
6/11/98	195	6	0.31	50.8	86.5	0	0	1.2	10.9	30.2	63.9	84.3	97.6	100		
6/11/98	195			122.1		0	0	0.8	6.9	23.2	48.9	68.6	82.1	100		
6/16/98	221		1.78	366.6	965.9	0.1	0.1	1.7	15.9	41.9	75.2	97.5	99	100		
6/16/98	221	30		1565.1		0	0	0.5	3.5	12.1	25.9	40.8	55.3	70.9	87.3	100
6/18/98	156		0.21	12.7	26.4	0	0	0.1	6.6	24.8	58.3	81.3	90.1	94.5	100	
6/18/98	156	5		40		0	0	0.2	11.7	39.4	74.2	93	100			
5/28/99	418	76	8.55	20.3	19.1	0	0.1	0.5	10.6	30.7	52.9	68.9	78.8	84.6	91.4	100
5/28/99	418			17.9		0	0	0.4	9.7	28.5	51.2	70.6	81.5	89.3	98	100
6/2/99	297	24	1.92	5.6	10.0	0	0	1.6	17.7	46	75.2	91.9	97.8	100	100	100
6/2/99	297			14.4		0	0	0.8	7	21.2	44.9	62	76.6	84.2	87	100
6/4/99	194		0.47	3.2	6.1	0	0.1	1.8	14.5	36.8	59.8	73.9	90.4	98.1	100	100
6/4/99	194	9		9		0	0.1	0.9	7.4	21	43.3	63	79.4	92.1	100	100
6/8/99	174		0.23	12.4	8.7	0	0	1.1	8.9	27.9	56.5	78.6	95.3	100	100	100
6/8/99	174	5		4.9		0.1	0.1	2.8	21.3	44.8	60.5	72	84.4	97.9	100	100
6/15/99	296	28	2.23	7	9.2	0	0.1	2	16.3	41.9	71.1	89	96	97.1	100	100
6/15/99	296			11.3		0	0.1	1.6	12.7	34	61.9	83.2	94.8	100	100	
6/17/99	284	19	1.45	12.8	8.9	0	0	0.7	5.7	18.8	42.1	66	83.4	93.4	100	100
6/17/99	284			4.9		0.1	0.1	2	16.7	40.5	71.3	87.4	96	100	100	100
6/22/99	148	7	0.28	0.4	0.6	0	0	2.7	20.9	51	78.3	94.9	100	100	100	100
6/22/99	148			0.767		0	0	2.2	16.7	36	61.2	74.9	89	89	100	100

Appendix H: Computation of daily sediment discharge for USGS station 1316225								
Date	Mean daily	Calculated	Calculated		Date	Mean daily	Calculated	Calculated
	discharge cfs	TSS load*	bedload**			discharge cfs	TSS load*	bedload***
		tons/day	tons/day				tons/day	tons/day
* based on equation $y = 0.21938E^{0.0149x}$							2190.9429	302.38354
** based on equation y = 1.2173*X - 86.333								
*** based on equation y = 0.05338x - 4.872								
4/22/98	60	0.5	0		10/1/98	7.1	0.2	0
4/23/98	94	0.9	28.0932		10/2/98	7.2	0.2	0
4/24/98	95	0.9	29.3105		10/3/98	7.8	0.2	0
4/25/98	72	0.6	1.3126		10/4/98	8.8	0.3	0
4/26/98	58	0.5	0		10/5/98	9	0.3	0
4/27/98	55	0.5	0		10/6/98	8.4	0.2	0
4/28/98	64	0.6	0		10/7/98	8.2	0.2	0
4/29/98	80	0.7	11.051		10/8/98	7.9	0.2	0
4/30/98	96	0.9	30.5278		10/9/98	7.6	0.2	0
5/1/98	115	1.2	53.6565		10/10/98	7.5	0.2	0
5/2/98	133	1.6	75.5679		10/11/98	7.5	0.2	0
5/3/98	132	1.6	74.3506		10/12/98	7.3	0.2	0
5/4/98	126	1.4	67.0468		10/13/98	7.1	0.2	0
5/5/98	114	1.2	52.4392		10/14/98	7.4	0.2	0
5/6/98	103	1.0	39.0489		10/15/98	7.6	0.2	0
5/7/98	110	1.1	47.57		10/16/98	7.7	0.2	0
5/8/98	129	1.5	70.6987		10/17/98	7.5	0.2	0
5/9/98	141	1.8	85.3063		10/18/98	7.4	0.2	0
5/10/98	147	2.0	92.6101		10/19/98	7.2	0.2	0
5/11/98	149	2.0	95.0447		10/20/98	7.2	0.2	0
5/12/98	151	2.1	97.4793		10/21/98	7.3	0.2	0
5/13/98	147	2.0	92.6101		10/22/98	9.2	0.3	0
5/14/98	131	1.5	73.1333		10/23/98	11	0.3	0
5/15/98	118	1.3	57.3084		10/24/98	8.3	0.2	0
5/16/98	119	1.3	58.5257		10/25/98	11	0.3	0
5/17/98	114	1.2	52.4392		10/26/98	10	0.3	0
5/18/98	107	1.1	43.9181		10/27/98	8.8	0.3	0
5/19/98	108	1.1	45.1354		10/28/98	11	0.3	0
5/20/98	116	1.2	54.8738		10/29/98	11	0.3	0
5/21/98	120	1.3	59.743		10/30/98	9	0.3	0
5/22/98	110	1.1	47.57		10/31/98	8.1	0.2	0
5/23/98	102	1.0	37.8316		11/1/98	9	0.3	0
5/24/98	104	1.0	40.2662		11/2/98	9.9	0.3	0
5/25/98	128	1.5	69.4814		11/3/98	8.7	0.2	0
5/26/98	157	2.3	104.7831		11/4/98	8.7	0.2	0
5/27/98	145	1.9	90.1755		11/5/98	9.3	0.3	0
5/28/98	146	1.9	91.3928		11/6/98	9.1	0.3	0
5/29/98	150	2.0	96.262		11/7/98	9.2	0.3	0
5/30/98	148	2.0	93.8274		11/8/98	9.2	0.3	0
5/31/98	141	1.8	85.3063		11/9/98	8.9	0.3	0
6/1/98	148	2.0	93.8274		11/10/98	8.7	0.2	0
6/2/98	186	3.5	140.0848		11/11/98	8.7	0.2	0

Date	Mean daily discharge cfs	Calculated TSS load*	Calculated bedload**		Date	Mean daily discharge cfs	Calculated TSS load*	Calculated bedload***
Appendix H: Computation of daily sediment discharge for USGS station 1316225								
		tons/day	tons/day				tons/day	tons/day
* based on equation y = $0.21938E^{0.0149x}$							2190.9429	302.38354
** based on equation y = 1.2173*X - 86.333								
*** based on equation y = 0.05338x - 4.872								
6/3/98	233	7.1	197.2979		11/12/98	8.3	0.2	0
6/4/98	191	3.8	146.1713		11/13/98	9.4	0.3	0
6/5/98	169	2.7	119.3907		11/14/98	11	0.3	0
6/6/98	157	2.3	104.7831		11/15/98	12	0.3	0
6/7/98	167	2.6	116.9561		11/16/98	11	0.3	0
6/8/98	214	5.3	174.1692		11/17/98	11	0.3	0
6/9/98	224	6.2	186.3422		11/18/98	10	0.3	0
6/10/98	188	3.6	142.5194		11/19/98	9.1	0.3	0
6/11/98	195	4.0	151.0405		11/20/98	9	0.3	0
6/12/98	228	6.6	191.2114		11/21/98	10	0.3	0
6/13/98	273	12.8	245.9899		11/22/98	10	0.3	0
6/14/98	259	10.4	228.9477		11/23/98	9.8	0.3	0
6/15/98	290	16.5	266.684		11/24/98	11	0.3	0
6/16/98	221	5.9	182.6903		11/25/98	10	0.3	0
6/17/98	192	3.8	147.3886		11/26/98	9.5	0.3	0
6/18/98	156	2.2	103.5658		11/27/98	9.9	0.3	0
6/19/98	158	2.3	106.0004		11/28/98	9.9	0.3	0
6/20/98	178	3.1	130.3464		11/29/98	9.6	0.3	0
6/21/98	185	3.5	138.8675		11/30/98	10	0.3	0
6/22/98	189	3.7	143.7367		12/1/98	9.3	0.3	0
6/23/98	178	3.1	130.3464		12/2/98	9.1	0.3	0
6/24/98	170	2.8	120.608		12/3/98	9.2	0.3	0
6/25/98	172	2.8	123.0426		12/4/98	8.1	0.2	0
6/26/98	171	2.8	121.8253		12/5/98	7.6	0.2	0
6/27/98	147	2.0	92.6101		12/6/98	7	0.2	0
6/28/98	138	1.7	81.6544		12/7/98	6.9	0.2	0
6/29/98	142	1.8	86.5236		12/8/98	6.1	0.2	0
6/30/98	151	2.1	97.4793		12/9/98	6.2	0.2	0
7/1/98	159	2.3	107.2177		12/10/98	6.6	0.2	0
7/2/98	156	2.2	103.5658		12/11/98	7.1	0.2	0
7/3/98	148	2.0	93.8274		12/12/98	7.9	0.2	0
7/4/98	129	1.5	70.6987		12/13/98	7.9	0.2	0
7/5/98	109	1.1	46.3527		12/14/98	7.7	0.2	0
7/6/98	95	0.9	29.3105		12/15/98	7.4	0.2	0
7/7/98	88	0.8	20.7894		12/16/98	7.5	0.2	0
7/8/98	75	0.7	4.9645		12/17/98	7.9	0.2	0
7/9/98	71	0.6	0.0953		12/18/98	7.8	0.2	0
7/10/98	67	0.6	0		12/19/98	7.7	0.2	0
7/11/98	59	0.5	0		12/20/98	7.8	0.2	0
7/12/98	52	0.5	0		12/21/98	7.8	0.2	0
7/13/98	47	0.4	0		12/22/98	7.8	0.2	0
7/14/98	43	0.4	0		12/23/98	7.6	0.2	0

Appendix H: Computation of daily sediment discharge for USGS station 1316225								
Date	Mean daily discharge cfs	Calculated TSS load*	Calculated bedload**		Date	Mean daily discharge cfs	Calculated TSS load*	Calculated bedload***
		tons/day	tons/day				tons/day	tons/day
* based on equation $y = 0.21938E^{0.0149x}$							2190.9429	302.38354
** based on equation y = 1.2173*X - 86.333								
*** based on equation y = 0.05338x - 4.872								
7/15/98	38	0.4	0		12/24/98	7.3	0.2	0
7/16/98	34	0.4	0		12/25/98	7.2	0.2	0
7/17/98	31	0.3	0		12/26/98	7.2	0.2	0
7/18/98	29	0.3	0		12/27/98	7.2	0.2	0
7/19/98	28	0.3	0		12/28/98	7.3	0.2	0
7/20/98	27	0.3	0		12/29/98	7	0.2	0
7/21/98	26	0.3	0		12/30/98	6.9	0.2	0
7/22/98	24	0.3	0		12/31/98	6.9	0.2	0
7/23/98	23	0.3	0		1/1/99	6.6	0.2	0
7/24/98	22	0.3	0		1/2/99	6.4	0.2	0
7/25/98	21	0.3	0		1/3/99	6.4	0.2	0
7/26/98	21	0.3	0		1/4/99	6.2	0.2	0
7/27/98	20	0.3	0		1/5/99	6.2	0.2	0
7/28/98	19	0.3	0		1/6/99	6.5	0.2	0
7/29/98	19	0.3	0		1/7/99	6.4	0.2	0
7/30/98	18	0.3	0		1/8/99	6.2	0.2	0
7/31/98	18	0.3	0		1/9/99	6.2	0.2	0
8/1/98	17	0.3	0		1/10/99	6.4	0.2	0
8/2/98	16	0.3	0		1/11/99	6.5	0.2	0
8/3/98	15	0.3	0		1/12/99	6.5	0.2	0
8/4/98	15	0.3	0		1/13/99	6.3	0.2	0
8/5/98	14	0.3	0		1/14/99	6.5	0.2	0
8/6/98	13	0.3	0		1/15/99	7.1	0.2	0
8/7/98	13	0.3	0		1/16/99	6.9	0.2	0
8/8/98	13	0.3	0		1/17/99	6.7	0.2	0
8/9/98	12	0.3	0		1/18/99	7.2	0.2	0
8/10/98	12	0.3	0		1/19/99	7.1	0.2	0
8/11/98	11	0.3	0		1/20/99	7.2	0.2	0
8/12/98	11	0.3	0		1/21/99	6.7	0.2	0
8/13/98	10	0.3	0		1/22/99	6.7	0.2	0
8/14/98	10	0.3	0		1/23/99	6.7	0.2	0
8/15/98	10	0.3	0		1/24/99	6.7	0.2	0
8/16/98	9	0.3	0		1/25/99	6.7	0.2	0
8/17/98	8	0.2	0		1/26/99	6.8	0.2	0
8/18/98	7	0.2	0		1/27/99	6.9	0.2	0
8/19/98	6.6	0.2	0		1/28/99	6.9	0.2	0
8/20/98	6	0.2	0		1/29/99	6.8	0.2	0
8/21/98	5.8	0.2	0		1/30/99	6.7	0.2	0
8/22/98	5.6	0.2	0		1/31/99	6.6	0.2	0
8/23/98	5.4	0.2	0		2/1/99	6.8	0.2	0
8/24/98	5.6	0.2	0		2/2/99	6.5	0.2	0
8/25/98	5.2	0.2	0		2/3/99	6.7	0.2	0

Appendix H: Computation of daily sediment discharge for USGS station 1316225								
Date	Mean daily discharge cfs	Calculated TSS load*	Calculated bedload**		Date	Mean daily discharge cfs	Calculated TSS load*	Calculated bedload***
		tons/day	tons/day				tons/day	tons/day
* based on equation $y = 0.21938E^{0.0149x}$							2190.9429	302.38354
** based on equation y = 1.2173*X - 86.333								
*** based on equation y = 0.05338x - 4.872								
8/26/98	5	0.2	0		2/4/99	6.6	0.2	0
8/27/98	5.1	0.2	0		2/5/99	6.5	0.2	0
8/28/98	4.7	0.2	0		2/6/99	6.7	0.2	0
8/29/98	4.3	0.2	0		2/7/99	7.2	0.2	0
8/30/98	4.2	0.2	0		2/8/99	7.1	0.2	0
8/31/98	4.3	0.2	0		2/9/99	7.1	0.2	0
9/1/98	4	0.2	0		2/10/99	7	0.2	0
9/2/98	3.7	0.2	0		2/11/99	6.9	0.2	0
9/3/98	3.7	0.2	0		2/12/99	6.9	0.2	0
9/4/98	3.8	0.2	0		2/13/99	7	0.2	0
9/5/98	4.2	0.2	0		2/14/99	6.9	0.2	0
9/6/98	4.6	0.2	0		2/15/99	6.9	0.2	0
9/7/98	4.1	0.2	0		2/16/99	6.8	0.2	0
9/8/98	4.7	0.2	0		2/17/99	7.1	0.2	0
9/9/98	6	0.2	0		2/18/99	7.1	0.2	0
9/10/98	6.3	0.2	0		2/19/99	7.2	0.2	0
9/11/98	6.3	0.2	0		2/20/99	7.2	0.2	0
9/12/98	17	0.3	0		2/21/99	7.1	0.2	0
9/13/98	7.9	0.2	0		2/22/99	7	0.2	0
9/14/98	6.2	0.2	0		2/23/99	6.9	0.2	0
9/15/98	5.6	0.2	0		2/24/99	7.1	0.2	0
9/16/98	5	0.2	0		2/25/99	7.3	0.2	0
9/17/98	4.7	0.2	0		2/26/99	7.3	0.2	0
9/18/98	4.6	0.2	0		2/27/99	7.2	0.2	0
9/19/98	4.9	0.2	0		2/28/99	7.6	0.2	0
9/20/98	5.4	0.2	0		3/1/99	8.6	0.2	0
9/21/98	9.5	0.3	0		3/2/99	8.5	0.2	0
9/22/98	9.3	0.3	0		3/3/99	8.6	0.2	0
9/23/98	10	0.3	0		3/4/99	8.4	0.2	0
9/24/98	9.6	0.3	0		3/5/99	8.3	0.2	0
9/25/98	7.1	0.2	0		3/6/99	8.1	0.2	0
9/26/98	17	0.3	0		3/7/99	8	0.2	0
9/27/98	9	0.3	0		3/8/99	7.9	0.2	0
9/28/98	7.5	0.2	0		3/9/99	7.8	0.2	0
9/29/98	7.2	0.2	0		3/10/99	7.6	0.2	0
9/30/98	7	0.2	0		3/11/99	7.5	0.2	0
					3/12/99	7.6	0.2	0
					3/13/99	7.8	0.2	0
					3/14/99	9.3	0.3	0
					3/15/99	10	0.3	0
					3/16/99	11	0.3	0
					3/17/99	14	0.3	0

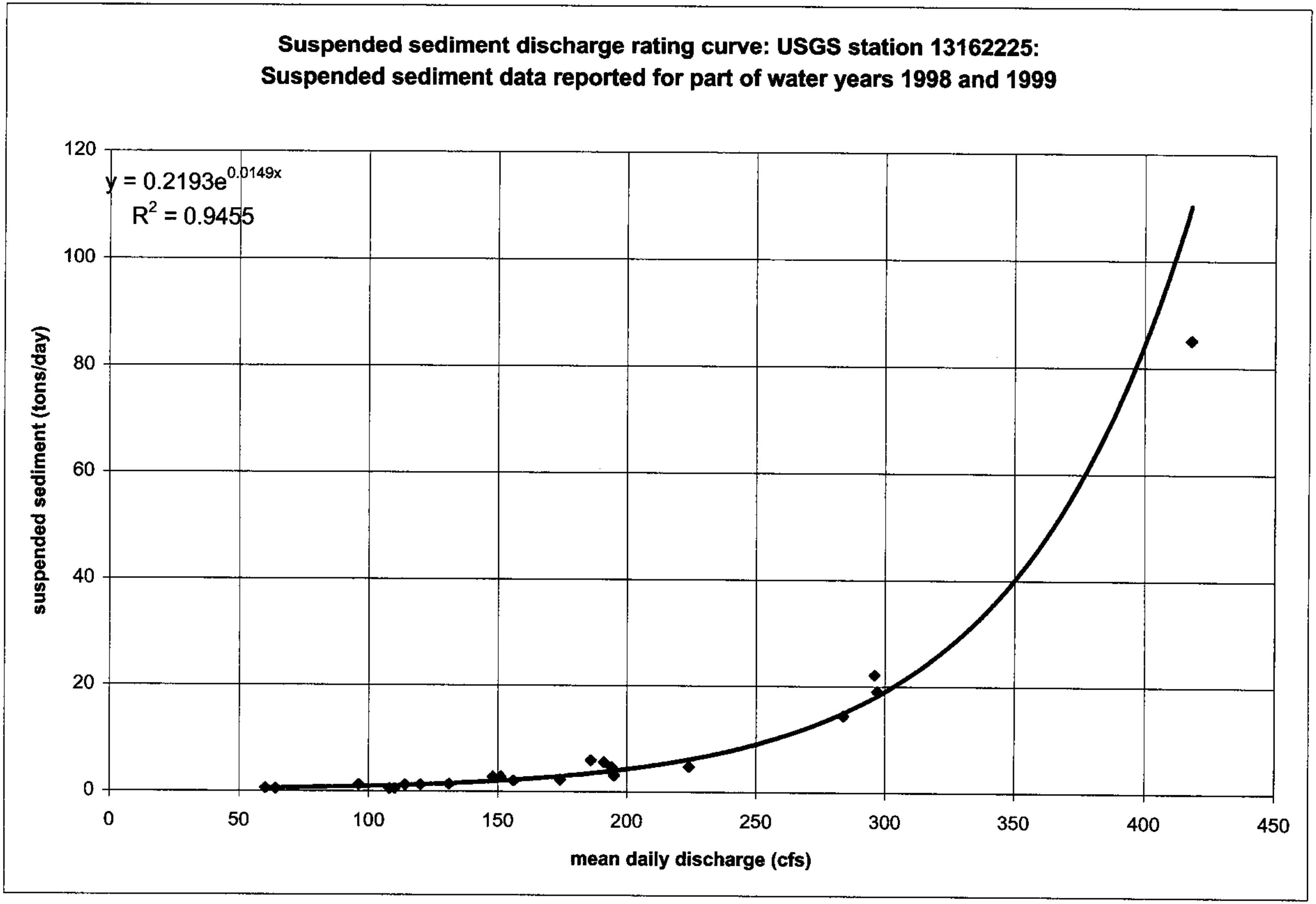
Appendix H: Computation of daily sediment discharge for USGS station 1316225								
Date	Mean daily	Calculated	Calculated		Date	Mean daily	Calculated	Calculated
	discharge cfs	TSS load*	bedload**			discharge cfs	TSS load*	bedload***
		tons/day	tons/day				tons/day	tons/day
* based on equation $y = 0.21938E^{0.0149x}$							2190.9429	302.38354
** based on equation y = 1.2173*X - 86.333								
*** based on equation y = 0.05338x - 4.872								
					3/18/99	18	0.3	0
					3/19/99	28	0.3	0
					3/20/99	32	0.4	0
					3/21/99	33	0.4	0
					3/22/99	28	0.3	0
					3/23/99	31	0.3	0
					3/24/99	39	0.4	0
					3/25/99	47	0.4	0
					3/26/99	39	0.4	0
					3/27/99	30	0.3	0
					3/28/99	23	0.3	0
					3/29/99	19	0.3	0
					3/30/99	17	0.3	0
					3/31/99	15	0.3	0
					4/1/99	14	0.3	0
					4/2/99	12	0.3	0
					4/3/99	11	0.3	0
					4/4/99	11	0.3	0
					4/5/99	11	0.3	0
					4/6/99	10	0.3	0
					4/7/99	10	0.3	0
					4/8/99	11	0.3	0
					4/9/99	10	0.3	0
					4/10/99	20	0.3	0
					4/11/99	10	0.3	0
					4/12/99	13	0.3	0
					4/13/99	18	0.3	0
					4/14/99	21	0.3	0
					4/15/99	23	0.3	0
					4/16/99	31	0.3	0
					4/17/99	44	0.4	0
					4/18/99	60	0.5	0
					4/19/99	74	0.7	0
					4/20/99	77	0.7	0
					4/21/99	65	0.6	0
					4/22/99	48	0.4	0
					4/23/99	37	0.4	0
					4/24/99	32	0.4	0
					4/25/99	40	0.4	0
					4/26/99	60	0.5	0
					4/27/99	71	0.6	0
					4/28/99	68	0.6	0

Appendix H: Computation of daily sediment discharge for USGS station 1316225								
Date	Mean daily discharge cfs	Calculated TSS load*	Calculated bedload**		Date	Mean daily discharge cfs	Calculated TSS load*	Calculated bedload***
		tons/day	tons/day				tons/day	tons/day
* based on equation $y = 0.21938E^{0.0149x}$							2190.9429	302.38354
** based on equation y = 1.2173*X - 86.333								
*** based on equation y = 0.05338x - 4.872								
					4/29/99	56	0.5	0
					4/30/99	46	0.4	0
					5/1/99	44	0.4	0
					5/2/99	66	0.6	0
					5/3/99	68	0.6	0
					5/4/99	57	0.5	0
					5/5/99	50	0.5	0
					5/6/99	59	0.5	0
					5/7/99	75	0.7	0
					5/8/99	87	0.8	0
					5/9/99	83	0.8	0
					5/10/99	70	0.6	0
					5/11/99	63	0.6	0
					5/12/99	71	0.6	0
					5/13/99	79	0.7	0
					5/14/99	70	0.6	0
					5/15/99	62	0.6	0
					5/16/99	54	0.5	0
					5/17/99	57	0.5	0
					5/18/99	74	0.7	0
					5/19/99	94	0.9	0.14572
					5/20/99	106	1.1	0.78628
					5/21/99	106	1.1	0.78628
					5/22/99	107	1.1	0.83966
					5/23/99	151	2.1	3.18838
					5/24/99	323	27.0	12.36974
					5/25/99	489	320.3	21.23082
					5/26/99	501	383.0	21.87138
					5/27/99	443	161.4	18.77534
					5/28/99	418	111.2	17.44084
					5/29/99	444	163.8	18.82872
					5/30/99	541	695.0	24.00658
					5/31/99	364	49.7	14.55832
					6/1/99	313	23.3	11.83594
					6/2/99	297	18.3	10.98186
					6/3/99	280	14.2	10.0744
					6/4/99	194	3.9	5.48372
					6/5/99	155	2.2	3.4019
					6/6/99	170	2.8	4.2026
					6/7/99	183	3.4	4.89654
					6/8/99	174	2.9	4.41612
					6/9/99	146	1.9	2.92148

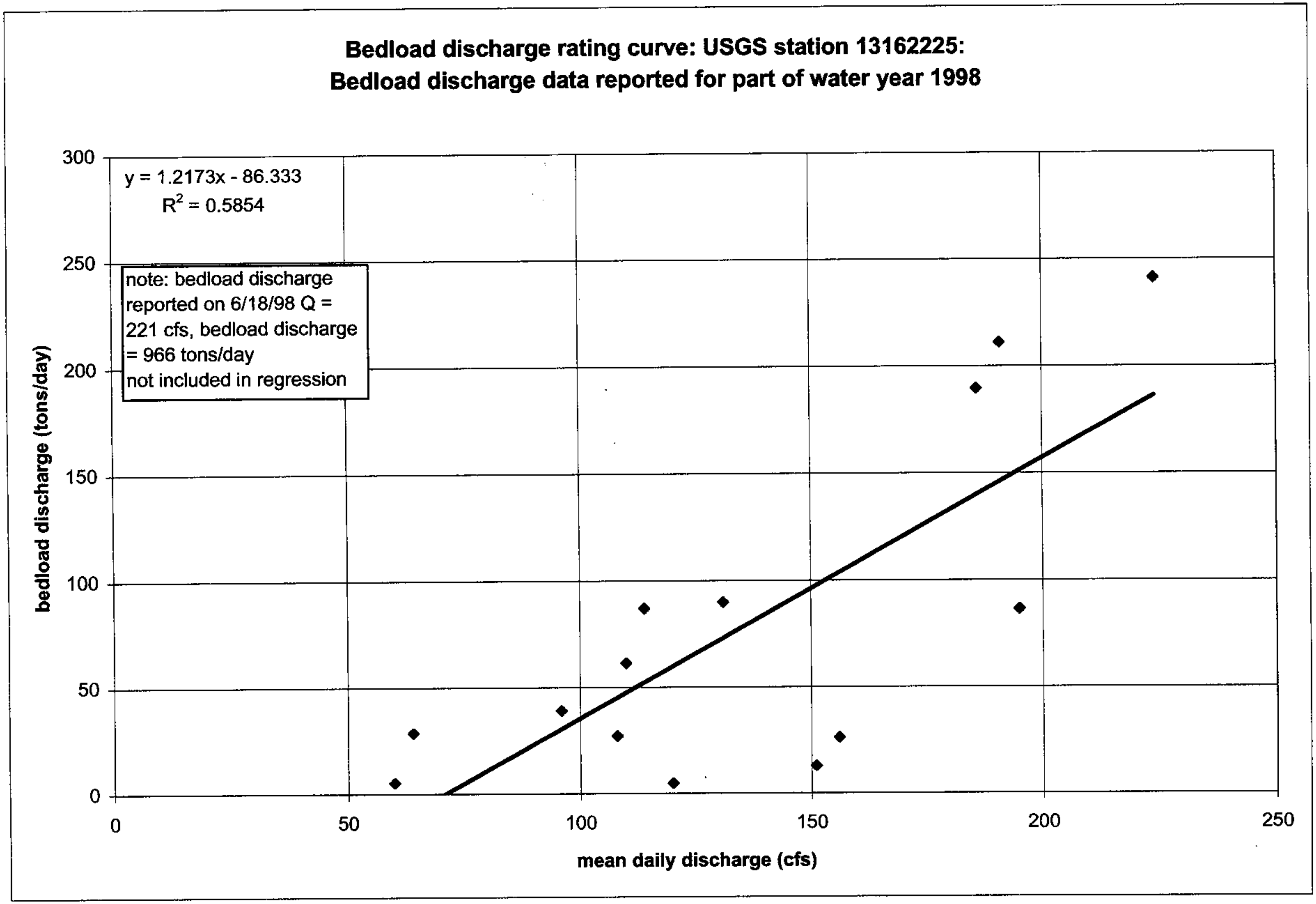
Appendix H: Computation of daily sediment discharge for USGS station 1316225								
Date	Mean daily discharge cfs	Calculated TSS load*	Calculated bedload**		Date	Mean daily discharge cfs	Calculated TSS load*	Calculated bedload***
		tons/day	tons/day				tons/day	tons/day
* based on equation $y = 0.21938E^{0.0149x}$							2190.9429	302.38354
** based on equation y = 1.2173*X - 86.333								
*** based on equation y = 0.05338x - 4.872								
					6/10/99	130	1.5	2.0674
					6/11/99	138	1.7	2.49444
					6/12/99	153	2.1	3.29514
					6/13/99	191	3.8	5.32358
					6/14/99	256	9.9	8.79328
					6/15/99	296	18.1	10.92848
					6/16/99	297	18.3	10.98186
					6/17/99	284	15.1	10.28792
					6/18/99	274	13.0	9.75412
					6/19/99	248	8.8	8.36624
					6/20/99	204	4.6	6.01752
					6/21/99	177	3.1	4.57626
					6/22/99	148	2.0	3.02824
					6/23/99	128	1.5	1.96064
					6/24/99	111	1.1	1.05318
					6/25/99	99	1.0	0.41262
					6/26/99	80	0.7	0
					6/27/99	65	0.6	0
					6/28/99	55	0.5	0
					6/29/99	51	0.5	0
					6/30/99	48	0.4	0
					7/1/99	43	0.4	0
					7/2/99	40	0.4	0
					7/3/99	36	0.4	0
					7/4/99	33	0.4	0
					7/5/99	29	0.3	0
					7/6/99	26	0.3	0
					7/7/99	24	0.3	0
					7/8/99	23	0.3	0
					7/9/99	21	0.3	0
					7/10/99	19	0.3	0
					7/11/99	18	0.3	0
					7/12/99	17	0.3	0
					7/13/99	17	0.3	0
					7/14/99	16	0.3	0
					7/15/99	16	0.3	0
					7/16/99	15	0.3	0
					7/17/99	15	0.3	0
					7/18/99	14	0.3	0
					7/19/99	14	0.3	0
					7/20/99	13	0.3	0
					7/21/99	12	0.3	0

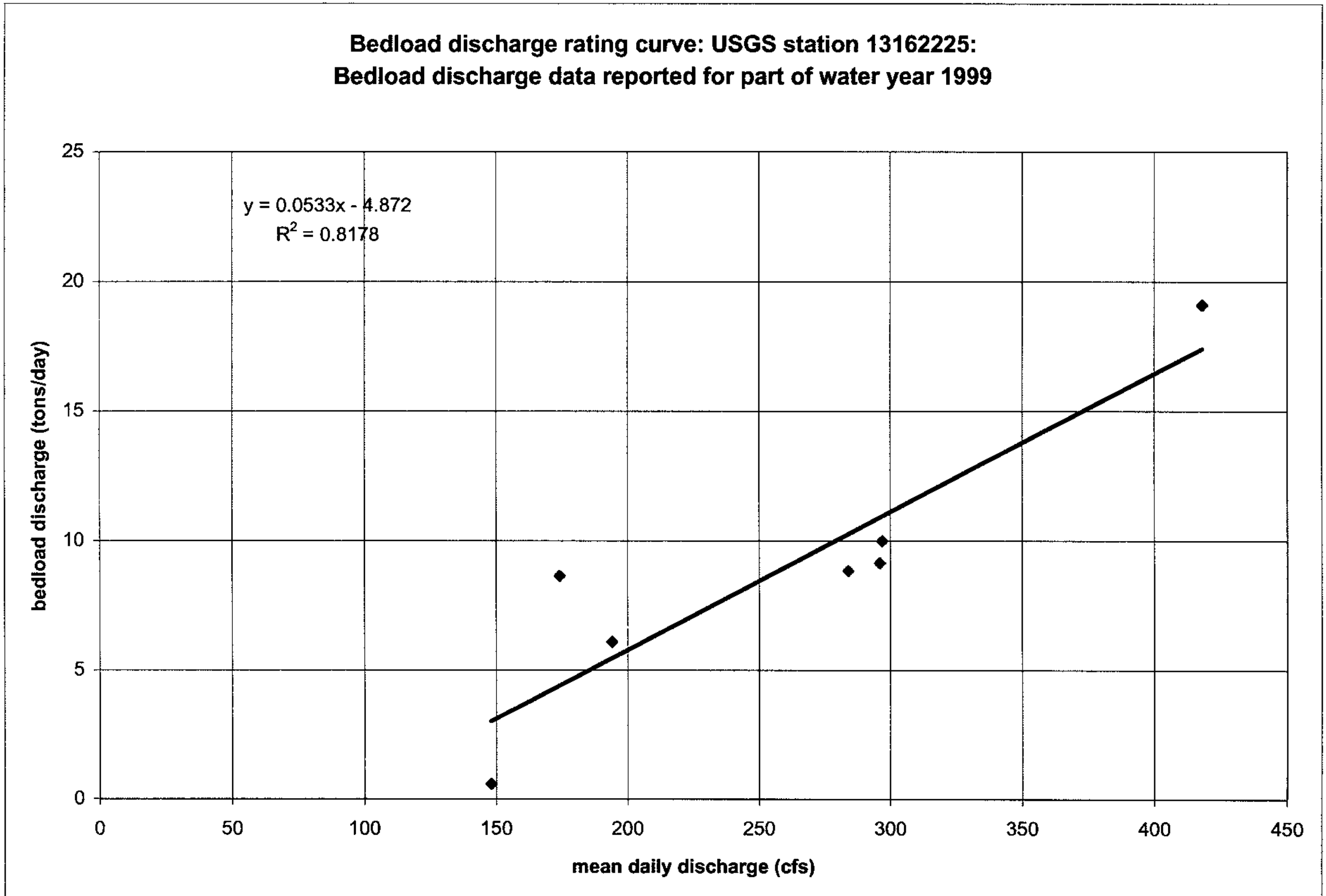
Appendix H: Computation of daily sediment discharge for USGS station 1316225								
Date	Mean daily	Calculated	Calculated		Date	Mean daily	Calculated	Calculated
	discharge cfs	TSS load*	bedload**			discharge cfs	TSS load*	bedload***
		tons/day	tons/day				tons/day	tons/day
* based on equation $y = 0.21938E^{0.0149x}$							2190.9429	302.38354
** based on equation y = 1.2173*X - 86.333								
*** based on equation y = 0.05338x - 4.872								
					7/22/99	12	0.3	0
					7/23/99	11	0.3	0
					7/24/99	11	0.3	0
					7/25/99	11	0.3	0
					7/26/99	11	0.3	0
					7/27/99	11	0.3	0
					7/28/99	10	0.3	0
					7/29/99	10	0.3	0
					7/30/99	9.9	0.3	0
					7/31/99	9.4	0.3	0
					8/1/99	9.1	0.3	0
					8/2/99	8.6	0.2	0
					8/3/99	8.2	0.2	0
					8/4/99	8.8	0.3	0
					8/5/99	9	0.3	0
					8/6/99	8.1	0.2	0
					8/7/99	7.8	0.2	0
					8/8/99	7.6	0.2	0
					8/9/99	7.1	0.2	0
					8/10/99	7.5	0.2	0
					8/11/99	8.6	0.2	0
					8/12/99	8.6	0.2	0
					8/13/99	7.3	0.2	0
					8/14/99	6.7	0.2	0
					8/15/99	6.7	0.2	0
					8/16/99	6.4	0.2	0
					8/17/99	6	0.2	0
					8/18/99	5.6	0.2	0
					8/19/99	5.8	0.2	0
					8/20/99	5.4	0.2	0
					8/21/99	5.6	0.2	0
					8/22/99	5.6	0.2	0
					8/23/99	5.2	0.2	0
					8/24/99	5	0.2	0
					8/25/99	4.9	0.2	0
					8/26/99	4.8	0.2	0
					8/27/99	4.6	0.2	0
					8/28/99	5	0.2	0
					8/29/99	4.8	0.2	0
					8/30/99	4.3	0.2	0
					8/31/99	4.7	0.2	0
					9/1/99	5.3	0.2	0

Appendix H: Computation of daily sediment discharge for USGS station 1316225								
Date	Mean daily discharge cfs	Calculated TSS load*	Calculated bedload**		Date	Mean daily discharge cfs	Calculated TSS load*	Calculated bedload***
		tons/day	tons/day				tons/day	tons/day
* based on equation $y = 0.21938E^{0.0149x}$							2190.9429	302.38354
** based on equation y = 1.2173*X - 86.333								
*** based on equation y = 0.05338x - 4.872								
					9/2/99	5.5	0.2	0
					9/3/99	5.8	0.2	0
					9/4/99	5.8	0.2	0
					9/5/99	5.2	0.2	0
					9/6/99	4.8	0.2	0
					9/7/99	4.8	0.2	0
					9/8/99	4.7	0.2	0
					9/9/99	4.3	0.2	0
					9/10/99	4.5	0.2	0
					9/11/99	4.4	0.2	0
					9/12/99	4.3	0.2	0
					9/13/99	4.2	0.2	0
					9/14/99	4.2	0.2	0
					9/15/99	4.3	0.2	0
					9/16/99	4.1	0.2	0
					9/17/99	4	0.2	0
					9/18/99	4.6	0.2	0
					9/19/99	4.9	0.2	0
					9/20/99	4.4	0.2	0
					9/21/99	4.4	0.2	0
					9/22/99	4.5	0.2	0
					9/23/99	4.5	0.2	0
					9/24/99	4.5	0.2	0
					9/25/99	4.2	0.2	0
					9/26/99	4.2	0.2	0
					9/27/99	4.6	0.2	0
					9/28/99	4.9	0.2	0
					9/29/99	5.1	0.2	0
					9/30/99	4.9	0.2	0



Suspended sediment discharge rating curve: USGS station 13162225:
Suspended sediment data reported for part of water years 1998 and 1999
$y = 0.2193e^{0.0149x}$
$R^2 = 0.9455$
suspended sediment (tons/day)
0
20
40
60
80
100
120
mean daily discharge (cfs)
0
50
100
150
200
250
300
350
400
450


Bedload discharge rating curve: USGS station 13162225:
Bedload discharge data reported for part of water year 1998
y = 1.2173x - 86.333
R2 = 0.5854
note: bedload discharge reported on 6/18/98 Q = 221 cfs, bedload discharge = 966 tons/day not included in regression
bedload discharge (tons/day)
300
250
200
150
100
50
0
0
50
100
150
200
250
mean daily discharge (cfs)


Bedload discharge rating curve: USGS station 13162225:
Bedload discharge data reported for part of water year 1999
y = 0.0533x - 4.872
R2 = 0.8178
25
20
15
10
5
0
bedload discharge (tons/day)
0
50
100
150
200
250
300
350
400
450
mean daily discharge (cfs)

APPENDIX I

Summary of Channel Changes

Appendix I: Summary of observed changes in channel pattern between 1993 and 2001 West Fork of the Jarbidge River		
Channel Segment	Length feet	Notes
CC-1	1366	Channel and road obliterated by debris from Snowslide Gulch Debris inputs veneered over area approximately 80 feet in width Channel planform changed - channel captured in former road prism
CC-2	3600	No change in planform local braiding observed upstream of Gorge Gulch evident in both photo sets
CC-3	800	Downstream of Gorge Gulch - No change in planform Approximately 11,000 square feet of debris-related deposition
CC-4	900	No change in planform Approximately 5,000 square feet of point bar growth
CC-5	660	Change in planform where road captured by channel Approximately 4,000 square feet of point bar growth
CC-6	1020	No change in planform since 1993 Includes restored reach, so influence of 1995 flood event lost
CC-7	1600	Very limited planform change Approximately 5,000 square feet of point bar growth adjacent to interior campground road at Pine Creek Campground Channel fully migrated to road at road-channel interaction reach R-20 causing channel instability and approximately 5,000 square feet of deposition
CC-8	2000	No change in planform No change in bar formation No change observed at bridge
CC-9	12000	This reach is identified as unstable due to bridges and road alignment Notable that there is very little change between photo sets in terms of planform and bar size or location. Many of the 1993 bar surfaces appear to be revegetating. Suggests that influence of debris flows limited to immediate downstream
CC-10	3400	Reach located in townsite No planform change observed Tailings upstream of Br-10 were mobilized by 1995 flood. Due to color of tailings and glare, cannot map change accurately with air photography
CC-11	3600	Channel re-aligned for 600 feet upstream of the bridge, In 1993 photo channel on left margin of valley Minor planform change in lower 30 percent of reach In both 1993 and 2001 photos, major depositional reach with similar bar extent
CC-12	4500	Minor planform change within same lateral gravel extent as observed in 1993 photos. Some increase in sinuosity between photo sets Channel has migrated ~ 15 feet further toward large fluvial surface downstream of landfill
CC-13	3400	No planform or bar surface change observed Bar surfaces which are evident in 93 photos are observed in 2001 photos

Appendix I: Summary of observed changes in channel pattern between 1993 and 2001 West Fork of the Jarbidge River	
Channel Segment	Notes
7000' contour interval to Cougar Creek	Minor amount of planform change Channel has same active gravel bar limits in each photo set Approximately 8,000 square feet of bar accumulation upstream of Cougar Creek
Cougar Creek to Fall Creek	No planform changes observed No detectable bar changes Very stable section
Fall Creek to Robinson Creek	Very minor planform changes Channel migrating through same gravel extents in each photo set